Language Acquisition across Linguistic and Cognitive Systems

Language Acquisition & Language Disorders 52

Edited by
Michèle Kail
Maya Hickmann

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Language Acquisition across Linguistic and Cognitive Systems

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Volume 52

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INTRODUCTION

New perspectives in the study of first and second language acquisition

Linguistic and cognitive constraints

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1. Introduction

Recent advances in cognitive sciences have lead to lively debates concerning the role of linguistic and cognitive determinants in language acquisition. This question is presently discussed across several disciplines (linguistics, psychology, neuroscience, computer science) where findings have shed light on the process of language acquisition, thereby also addressing fundamental questions concerning the nature of language and of our language faculty. Determining the relative weight of linguistic and cognitive constraints on acquisition requires a perspective that is both multidisciplinary and comparative in order to bring together different strands of research emerging from the simultaneous study of linguistic and cognitive systems across diverse languages, as well as across learners and learning situations: first language acquisition by children, early bilingualism, second language acquisition by children and by adults. Such a perspective is the main contribution of this volume.[1]

1. A first version of the articles in this volume appeared in Kail, Fayol & Hickmann (2008), published by CNRS Editions, although all have been entirely revised and updated for the present volume.

2. Language acquisition: The debates

Language acquisition is one of the most fundamental dimensions of human cognition and a major source of reflection in the history of science. During the last twenty years or so, this field has undergone radical developments through new theoretical proposals as well as through the development of sophisticated methodologies that have allowed major advances in several disciplines of the cognitive sciences. This newly redefined and expanded field of research has major social implications and comprises remarkably diverse branches: the comparative study of different types of learners (children, adults), during normal and pathological development, with source and/or target languages presenting different properties and in different learning situations – spontaneous or guided acquisition at different ages and levels of competence, early bilingualism, later acquisition of a second language or of several languages in different sociolinguistic contexts.

The emergence of language during first language acquisition constitutes a turning point in children's development resulting in the mastery of a powerful symbolic system providing them with the necessary basis to reach complex levels of social and cognitive functioning. Language disorders in children represent a major social issue for public health requiring reliable diagnostic tools as well as appropriate and efficient remediation methods in need of much further research. Furthermore, the massive migration flows in today's world have resulted in such pervasive bilingualism or multilingualism that the previously predominant model of the monolingual speaker has become a rare exception.

Despite a growing number of relevant studies and many important theoretical advances, proposals still diverge with respect to some fundamental questions concerning the mechanisms underlying language acquisition. The old debate concerning whether the language faculty is innate versus learned in the human species has been revisited in light of connectionist models that propose a new perspective on development (Elman, Bates, Johnson, Karmiloff-Smith, Parisi & Plunkett 1996), although no consensus has yet been reached in this respect (Rispoli 1999). Furthermore, the question of the modularity of linguistic knowledge has been addressed in many studies that now combine behavioural measures with neuro-imagery (electroencephalography, functional brain imaging). The question is still open as to whether the activation of neural networks reflects a functional organization that is modular, serial and hierarchical (Gorell 1995; Friederici & Weissenborn 2007) or rather interactive, parallel and distributed (Mac Donald, Pearlmutter & Seidenberg 1994; Fuster 2006). Similarly, new behavioral and neuro-imaging data (Friederici & Thierry 2008) have begun to examine again the extent to which development is continuous or discontinuous. New neo-Whorfian research (since Berman & Slobin 1994; Choi & Bowerman

1991; Bowerman 1996; Slobin 1996) have also made proposals concerning the impact of language-specific properties on the development of linguistic competence. Finally, it still remains to be determined whether linguistic competence must be linked to language use in relation to discourse context, as claimed by some recent 'emergentist' theories that see input properties as a crucial driving force in the process of language acquisition. In this respect, Tomasello (2003) provides new insights on developmental change by studying emergent language within a usaged-based approach derived from cognitive and functional linguistics. In addition, the theory of dynamic systems (Thelen & Smith 1994) has reconceptualized the nature and form of changes during child development.

These questions among many others have given rise to divergent proposals. The aim of this volume is to show how the study of language acquisition is now able to generate and learn from renewed debates among models that cohabit within the field and that are less polarized than they were during past phases characterized by unproductive antagonistic clashes between different schools of thought (e.g. Generative Grammar vs. Connectionism). Different theories have benefitted from such exchanges, particularly from interdisciplinary bridges that have promoted new approaches based on expanded empirical bases resulting in more complex and more precise proposals.

3. Coverage and aims of the volume

The volume as a whole covers three large domains in the study of language acquisition: first language acquisition, bilingualism, and second language acquisition. The chapters offer novel contributions in all of these lines of research and propose some of the most promising research directions at the forefront of the field. The general aim of the volume is to provide multidisciplinary and comparative perspectives on language acquisition concerning multiple and variable facets of typical and atypical language development within a large age range as well as across languages and learners.

3.1 Intersciplinary perspectives on language acquisition

The first aim of the volume is to present current debates within an interdisciplinary framework that brings together research from different scientific traditions all concerned with language in the Cognitive sciences. These include diverse branches of linguistics (descriptive linguistics, typology, structurally and functionally oriented acquisition models), different branches of psychology (psycholinguistics,

cognitive psychology, infant and child psychology), the study of the neural substrates of language in neuroscience, and the use of computer simulation and modelling. The synergy thus obtained makes it possible to weigh the cognitive implications of fundamental (universal or variable) properties of linguistic systems for language acquisition by children or by adults. Furthermore, the volume integrates new research tools, some of which are presently proliferating (Sekerina, Fernandez & Clahsen 2008), such as the recording of brain activity, the on-line analysis of language processing, the construction of large cross-linguistic corpora, the use of Internet or of multimedia.

3.2 Multiple facets of linguistic competence in a large developmental age range

Depending on the questions addressed and on the theoretical approaches adopted, the chapters concern different language components during acquisition (phonology, morphology, syntax, the lexicon, semantics, pragmatics and discourse organization). Furthermore, these multiple facets of learners' linguistic competence are examined in different types of language behaviours (perception, comprehension, production). In this respect, the volume as a whole covers a large age range in development, addressing issues that concern infants' initial perceptual and comprehension capacities during the pre-linguistic phase to varied behaviours on the part of children and adults during early phases (the emergence of children's first language(s) and the beginning stage of adult learners' second language) to later phases of language acquisition by both child and adult learners.

3.3 Comparative perspectives: Acquisition across languages

A strong wish of the editors is to show the crucial contribution of comparative research that systematically contrasts different languages as well as different types of learners. With respect to cross-linguistic perspectives, the volume proposes comparisons among a large range of languages that examine the role of specific properties of linguistic systems in acquisition. Beyond the intrinsic relevance of such cross-linguistic comparisons, typological approaches (e.g. Talmy 2000) appeal to clusters of properties, thereby contributing notions such as linguistic 'distance' or 'resemblance' among language 'families' to the study of language acquisition. Depending on the studies and their domains, the selected languages present contrasts that are relevant from a cognitive point of view for child or adult learners, such as contrasts in morphological richness and transparency, structural variations or lexicalization patterns. Developments in the field now make such comparisons

indispensable in various disciplines where researchers cannot limit themselves to isolated languages anymore if they want to generalize conclusions concerning the nature of language and to explain the processes underlying its development.

3.4 Comparative perspectives: Acquisition across learners

With respect to comparisons across different types of learners, the volume brings together studies concerning the following populations: monolingual adult speakers (using their first language), monolingual children (acquiring their first language), bilingual speakers (adults and children who master two languages simultaneously and/or have learned two mother tongues), adults or children learning a second language (at different levels of competence and with different levels of dominance of one language in relation to the other). Such comparisons make it possible to isolate some factors that are normally confounded during development. For example, children's cognitive system grows with their first language(s), whereas adults are already equipped with a fully developed cognitive system when they come to the task of acquiring a second language. In addition, learning two languages at once (early bilingualism) or learning a second language (successive acquisition) confronts learners with two systems that may have very different properties affecting the acquisition process. Such comparisons allow us to address major questions such as the relative weight of cognitive and linguistic determinants, as well as the role of 'critical' periods in language acquisition.

3.5 Intra- and inter-individual variations in typical development

The volume also addresses the question of inter- and intra-individual variations that have been recurrently observed during normal development but insufficiently taken into account within a larger theoretical framework (Lautrey, Mazoyer & Van Geert 2002). When such variations are viewed as reflecting differences in rhythms, strategies and developmental trajectories, and/or as reflecting transitions, fluctuations and regressions within a given individual at a given moment in time, they become an intrinsic dimension of development, as first noted in the pioneering work of Bates, Dale & Thal (1995).

3.6 Language disorders and atypical development

Variability is also at the center of studies comparing typical and atypical development, including Williams syndrome, Down syndrome, mental retardation, children with cerebral lesions, aphasia, dyslexia, or Specific Language Impairments

(SLI). In addition to providing obviously relevant information to understand and help patients, such research can also bring evidence that sheds new light on different hypotheses in these debates. Thus, some of these disorders show dissociations between knowledge domains that are normally confounded during development, such as dissociations between verbal and non-verbal spatial capacities (Williams syndrome), between grammatical and lexical knowledge (aphasia), or between syntax and a variety of other language components (SLI). This type of research can relate genotypes and phenotypes, differentiate developmental delay from atypical profiles, assess the role of behavioural and cerebral plasticity in compensation and remediation processes, as well as test hypotheses concerning the relative autonomy vs. interactivity of different components of human cognition.

4. Contents of the volume

A first set of chapters (Part I) presents available models of language acquisition and paradigms developed in different disciplines to address the above questions, with particular emphasis on the need to invent new experimental paradigms. As shown by the subsequent two sets of chapters, the cross-linguistic perspective has lead to breakthrough findings and remains particularly productive in the study of first language acquisition (Part II) as well as in the study of bilingualism and second language acquisition (Part III).

4.1 Part I – The emergence and dynamics of language acquisition and language disorders

MacWhinney opens the volume with an overview of the theoretical frameworks that are currently most predominant in the study of language acquisition: Chomsky's theory and the functional connectionist approach. Starting with a list of premises and hypotheses differentiating these two major theoretical perspectives, he then lists eight fundamental and debated questions that highlight in detail the divergences between them: (1) the relevance of the distinction between competence and performance; (2) the importance of recursion in defining natural language and (3) its role in phylogenetic evolution; (4) the genetic basis of the language faculty (and of language disorders); (5) the 'special' status of the language faculty; (6) the importance of a 'critical period' for language acquisition; (7) the modular or interactive nature of knowledge domains; (8) the role of the input. MacWhinney concludes by suggesting that only new methodologies will allow us to support one or the other of these two major paradigms. These include

large cross-linguistic corpora of productions collected in natural or experimentally controlled situations that can be analyzed through the development of Internet and of computational power in the further study of language acquisition in different language domains (phonology, gestures, pragmatics, conversation).

Van Geert pursues these thoughts by showing the usefulness of modelling, particularly within a dynamic systems approach to language acquisition. Dynamic systems comprise numerous components that follow different trajectories, the properties of which result from the dynamic interactions among them. A large range of components can provide indices for the mechanisms underlying change (number of words or of prepositions in utterances…). These observations can be stochastic indicators underlying, for example, transitions between distinct generator mechanisms, continuities or discontinuities, and regressions. A first way to better understand the dynamic acquisition process consists in modelling interactions and in comparing the qualitative properties of the data simulated in this model with the one that is observed in child data. A second approach consists in applying flexible smoothing techniques to serial data and to determine possible changes in the volume of fluctuations observed in the data. The discovery of indices showing transitions and a phase-like grammatical development in some studies raises new questions concerning the linguistic properties of children's productions.

Christophe, Millotte, Brusini and Cauvet address what is known as *bootstrapping question*, taking the following paradox as their starting point: for each language component to which children are confronted (lexicon, phonology, syntax…), knowledge in other domains would simplify acquisition. For example, to the extent that syntactic structure can specify relations among the words in a given sentence, children should have access to words and their meanings in order to learn syntax. Conversely, learning the meanings of words should be easier if children have access to some aspects of syntactic structure. Christophe et al. present findings showing that children can learn some structural aspects of their language on the basis of a surface analysis of the speech to which they are exposed. In particular, sentence prosody and grammatical words can interact during early acquisition. Thus, children have access to intermediate prosodic groups as early as during their first year of life and they exploit these phonological groups to constrain word segmentation. In addition, at two years of age, they can exploit grammatical information to infer the categories of unknown words (nouns vs. verbs) and to partially guess their probable meanings (object vs. action). Finally, as shown by results obtained with adults, it is possible that children may be able to construct partial syntactic structures by relying simultaneously on boundaries across phonological groups and on grammatical words.

Thomas closes this section by proposing a synthesis of research concerning language disorders proposing that developmental disorders should be viewed in terms of changing constraints on language acquisition. Thomas illustrates this view by comparing the linguistic profiles of children that suffer from autism, Down syndrome, Williams syndrome and SLI, suggesting that similarities and differences among these disorders can be interpreted in terms of the properties of the learning system. A detailed description of Williams syndrome and SLI shows the usefulness of interpreting atypical language development in terms of the trajectories of an adaptive system that is governed by altered constraints (reasoning and information). According to such a view, the first type of disorder is characterized by *redundancy*, the second one by *compensation* to be studied first and foremost through functional brain imagery.

4.2 Part II – First language acquisition: universals and linguistic diversity

In Part II, **Lieven** first presents an overview of advances obtained within a cross-linguistic perspective during the last twenty years, showing how this comparative approach has become indispensable in the study of language acquisition since some pioneering proposals during the 20th century (MacWhinney & Bates 1989; Slobin 1985). A growing number of studies now rely on cross-linguistic comparisons between distant or closely related languages as a necessary tool to generalize results or to refute particular hypotheses concerning language acquisition. This research uses various methodologies implying the study of early spontaneous productions, experimentation or modelling. Lieven argues that the joint study of acquisition in several languages is the only way to provide psychologically convincing and realistic theories that can account for the processes whereby children build syntax in their first language.

Dressler stresses the relevance of research within a typological perspective that groups languages in terms of 'families' on the basis of properties that play a central role in language acquisition and according to several epistemological levels (classification, order, quantification). He illustrates this approach in the domain of morphology, examining in particular the impact of several language properties in this domain (richness, transparency, uniformity, productivity) on early phases of the acquisition of inflectional morphology. The general hypothesis is that during their social interactions children are sensitive to the typological properties of their mother tongue, noticing the structural and communicative importance of the linguistic patterns to which they are exposed during acquisition. Thus, the richer the morphology, the more quickly it is acquired. In addition, uniform and productive patterns are acquired more quickly than patterns that

are more opaque, not uniform and non productive. On the basis of these results, Dressler indicates the need to take into account the ways in which languages (or more precisely subsystems of languages) can be ordered according to the degree to which they approximate ideal morphological types, particularly the agglutinative inflectional (-fusional) and isolating type in the case of morphology.

The subsequent two chapters present divergent views of how children acquire spatial language and their implications for the language-cognition interface. According to one view (Landau & Jackendoff 1993), spatial representations are based on universal cognitive processes that are reflected in universal linguistic distinctions. However, the considerable variations that characterize spatial systems across languages has lead to neo-Whorfian views of language acquisition (e.g., Slobin 1996), according to which language-specific properties have an impact on the rhythm and course of development. In the context of this debate, **Hickmann** presents an overview of research comparing the expression of motion by children (two to ten years) in French and in English. As predicted on the basis of typological properties, the results show systematic cross-linguistic differences in how children select and organize spatial information. At all ages the semantic density of responses is higher in English than in French as a result of the fact that English speakers use compact structures in which they systematically lexicalize cause and/or manner in the verb root to which they add path in satellites. These structures are readily available from two years on in English, whereas more varied and complex structures are necessary to express multiple types of information in French. The discussion highlights research directions that will be necessary to test strong hypotheses concerning the potentially deeper effect of such language effects on cognition.

In sharp contrast, **Pléh** presents two sets of findings that support the opposite universalistic approach. A first set of findings concerns child Hungarian and shows the existence of a universal cognitive tendency to attribute a priviledged status to goals from very early on in a language that requires distinctions concerning path (for example, *in* with or without a change of location). Furthermore, this tendency can also be observed among speakers suffering from Williams syndrome, characterized by the under-development of posterior parietal regions of the brain that result in important deficits in spatial cognition. A second set of results presenting detailed comparisons between patients and healthy subjects shows no qualitative differences in their use of spatial language. Pléh concludes that these two groups carry out identical cognitive operations and only differ with respect to their computational capacities. This conclusion suggests a universal cognitive basis for the development and organization of spatial language.

Another component of children's linguistic competence, considered to be most fundamental by all models, is the marking of subject/object or agent/patient

roles in relation to the argument structure of the verb in various constructions. **Jisa et al.** examine how adults and children (five to ten years) in several language groups (Amharic, English, French, Hungarian) use different structural options to express event representations in narrative discourse. The analyses focus on grammatical constructions used to manipulate reference to entities in event representations involving role switches on the part of main characters who punctually change from being an agent to being a patient undergoing the action of a secondary character at different points of the plot. Narrative productions show a wide range of available structures (preposed patients, dislocations, inversions). These structures vary as a function of age and language, indicating a developmental progression in children's capacity to adopt different perspectives and to make choices between competing constructions in order to switch perspectives.

Kail, Costa and Hub Faria highlight the fact that on-line language processing in different languages has still not been sufficiently explored in language acquisition research. They report on studies they conducted in a number of languages using the paradigm of grammaticality judgments with monolingual and bilingual speakers. In this chapter, they compare on-line language processing by monolingual French and Portuguese subjects (adults and children between six to twelve years). The results first suggest the impact of some universal constraints. Thus, from six years on, in French and in Portuguese (as well as in other languages), violations that occur late in the sentence are more rapidly detected that those that occur early, indicating that subjects are able to use morphosyntactic information to make predictions on subsequent parts of the sentence. However, other constraints are language-specific. Thus in Portuguese, but not in French (or in some other languages), the validity of cues (morphology and word order) and the structural proximity (intra- vs. inter-syntagmatic violations) are influenced from six years on by the phonological detectability of morphological markings in oral speech.

Perdue's chapter makes the transition between Parts II and III in that it examines the expression of finiteness during both first and second language acquisition. This language domain has given rise to numerous analyses in a cross-linguistic perspective. Although the morphosyntactic categories of person and tense have been traditionally associated with finite propositions (in contrast to infinitives), finiteness also has semantic and pragmatic implications that have led several authors to propose a distinction between *morphological* (Fin-M) vs. *semantic* (Fin-S) finiteness. Taking this distinction as a starting point, Perdue analyzes the use of finiteness markings by two types of learners: adults acquiring French or a Germanic language as a second language (L2) who were tested in comparable verbal tasks; and children acquiring the same target languages as their mother tongue (spontaneous L1 productions). The analysis shows some similarities in the phases and acquisition paths observed in these different learners, but also

differences in their level of 'success' during the acquisition of verbal morphology that help to understand the organization and functioning of finiteness in language more generally.

4.3 Part III – Bilingualism and second language acquisition: A multidisciplinary perspective

Meisel argues for the need to integrate the fundamental concept of the *age of onset* of acquisition through a wide comparison among several types of learners: children acquiring one or two mother tongues at the same time (L1 and 2L1), as well as children or adults acquiring a second language (cL2 and aL2). He notes that comparing aL2 with L1 confounds age of onset and exposure to more than one language, suggesting that aL2 should be rather compared to 2L1 or to cL2. He further notes that 2L1 children have developed grammatical knowledge in each of their languages that is comparable to monolingual children and argues that language cL2 children who are exposed to a second language from five years on are more similar to aL2 learners than to L1 children. He concludes that the differences observed between 2L1 and aL2 reflect fundamental differences related to learners' linguistic knowledge, providing evidence for the *Critical Period Hypothesis*, further supported by some recent neuropsychological data. According to this proposal, crucial parts of the LAD (*Language Acquisition Device*) that guide L1 acquisition become inaccessible to aL2 learners because of neuronal maturation, so that these learners must rely on other compensatory cognitive resources and their linguistic knowledge must be viewed as a special hybrid system.

Schlyter starts with the observation that the development of inflectional morphology is closely tied to syntactic development within the framework of generative grammar. Focusing on subject-verb agreement, Schlyter first stresses the fact that this development is slow among Swedish-speaking adult learners of French L2 in both the oral and the written modalities, notwithstanding differences between these two modalities. She then points out that this development does not seem to be linked to syntactic development. Thus, contrary to what has been proposed for children and for adults, it is not possible to consider subject pronouns as person markings since their clitic status is not clear. Schlyter puts forth the hypothesis that syntax and morphology are separated in adult learners and that morphological development could be linked to frequency effects in the input. This development is compared to the one that is observed in other types of learners, particularly in bilingual French-Swedish children who also show a slow development of verbal agreement. Taken together, these results call for new cross-linguistic comparisons necessary to contrast input varieties from a morphological point of view.

The two subsequent chapters concern vocabulary acquisition in bilingual or second-language adult learners. As pointed out by **Grainger, Midgley and Holcomb**, the last twenty years of research on bilingualism have lead to a generic model of how bilinguals process lexical information. This model highlights the role of inhibitory control mechanisms that limit interferences between languages. Such a theoretical approach contrasts with classical models of lexical processing in second language learners during early acquisition stages that highlight the importance of excitatory connections among translation cognates. The authors present key results in these two research fields, as well as their own research in progress that focuses on the 'missing link' – that is on vocabulary development in a second language. This ongoing research now combines behavioural and electrophysiological measures necessary to understand the nature of the interactions that take place between lexical representations in L1 and in L2, as well as their development as a function of the learner's increasing competence in L2.

De Groot and van den Brink present related research on vocabulary learning during the acquisition of a foreign language. Taking as their starting point previous research involving direct teaching methods (recall cues, paired associate picture-word or word-word learning) typically used during the first phases of vocabulary learning in a foreign language by late learners, they examine other parameters affecting vocabulary learning beyond early phases in these late learners. Their findings show effects that are linked to resemblance, to the concreteness of nouns, to frequency in L1, and to typicality in L2. In order to account for these results, different hypotheses take into account the role of previous knowledge in long-term memory and the role of short-term phonological memory.

The last two chapters illustrate the new questions that have arisen from the growing use of brain-imagining methodologies in the study of language acquisition. **Pallier** shows that most previous brain-imagining studies focus on bilingual speakers or second language learners and examine the relative differentiation or overlap among brain areas involved in using one or the other language. This research has aimed particularly at understanding the role of several factors, such as the age at which second language acquisition begins or the learners' level of proficiency in the second language. In his recent and ongoing research, Pallier focuses on new questions, emphasizing the need for many studies to come before adequate answers can be found: Are there anatomical and/or functional differences in the brains of monolinguals and bilinguals? Do some neural correlates of inter-individual differences characterize subjects' capacity to learn a second language?

Similarly, **Reiterer** presents research focusing on the neural bases of bilingualism and L2 acquisition, borrowing examples from neuropsychological findings concerning bilingual aphasic patients, from brain-imagining research using fMRI and PET, and from her own research using ERP. Like Pallier, she points out that the first findings on the bilingual brain have focused on determining brain areas that might be differentially involved in the use of one or the other language in comparison the monolingual brain. Although this question remains controversial, new questions have arisen concerning factors such as age of acquisition, proficiency level, as well as length and quantity of exposure to the second language. In recent years a growing number of studies have begun to provide a solid empirical basis to assess the role of these factors. According to Reiterer, with increasing inter-disciplinary research among the cognitive sciences, brain imagining studies of second language acquisition should be able to integrate new variables that may crucially influence L2 acquisition, such as inter-individual differences, personality traits or social dimensions, all of which have been recently examined in the neurosciences.

5. Concluding remarks

The last twenty years have witnessed the development of promising methodologies and innovative paradigms that have brought substantial findings concerning language acquisition that previously could not have been expected or that were discussed as entirely speculative ideas. Theoretical perspectives have also entirely renewed old questions or defined new routes to explore bilingualism or language disorders. Finally, recent developments in modelling have played the same role for psycholinguistics as mathematics have done for physics. Language studies are now able to address simultaneously lively debates by associating pathology, including disorders that can be experimentally and temporarily provoked by TMS, experimental on-line studies concerning adults and children, research using brain-imaging techniques, and simulations that make it possible to symbolically manipulate pseudo-lesions in the brain or systematic modifications of basic parameters, such as processing speed or the efficiency of inhibitory mechanisms. Such a scientific context creates unprecedented opportunities towards the understanding of the complexity underlying the mechanisms of language acquisition. Motivated questions can now be precisely formulated on the basis of enriched empirical grounds and intriguing findings will require further methodological and theoretical advances.

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PART I

Emergence and dynamics of language acquisition and disorders

CHAPTER 1

A tale of two paradigms

Brian MacWhinney

The modern study of language, particularly as practiced in the Anglophone community, can be viewed as the tale of two competing paradigms: Universal Grammar (UG) and emergentism. These two paradigms take fundamentally different positions on these eight core issues: competence-performance, the centrality of recursion, the sudden evolution of language, the genetic control of language, the idea that speech is special, critical periods for language learning, neurological modules supporting language, and the poverty of the stimulus to the language learning. For researchers in the UG tradition, the vision of a recent evolution of language triggered by mutation in a few select genes predicts the formation of language modules, structures supporting recursion, and critical periods. Emergentists view language evolution as a gradual process based on dozens of mutations that impact general purpose cognitive and physiological mechanisms in many flexible ways. For emergentists, recursion and competence are not hard-wired facilities, but emergent abilities. Because of its greater complexity, the articulation of the emergentist position has depended heavily on advances in computer technology and the growth of multimedia databases, imaging technology, neural network modeling, and methods for dynamic assessment.

1. Introduction

The modern study of language, particularly as practiced in the Anglophone community, can be viewed as a tale of two competing paradigms. One of these paradigms is the discipline of generative grammar, as formulated by Chomsky and his coworkers. The goal of a generative grammar is the formulation of a device that can enumerate all grammatical sentences of a language and no ungrammatical sentences. Generative grammar broke onto the linguistic scene in 1957 with the publication of *Syntactic Structures* (Chomsky 1957) and Chomsky's (1959) devastating review of Skinner's *Verbal Behavior*. Later, Chomsky (1963) and Miller and Chomsky (1963) outlined the consequences of the approach for formal models of

language users. The paradigm achieved fuller articulation in subsequent formulations (Chomsky 1965, 1981, 1995; Chomsky & Lasnik 1993). These later versions of generative grammar emphasized the extent to which the core of language is identical across all humans. Chomsky referred to this as the theory of Universal Grammar (UG). Biological support for UG was presented in Lenneberg (1967), and Fodor's (1983) analysis of modularity of mind provided additional grounds for linking UG to cognitive science.

The second paradigm has developed more recently. It emphasizes the emergence of linguistic structure from natural processes in the brain, body, and society. This paradigm brings together work on cognitive linguistics (Langacker 1987), functional linguistics (Givón 1979), neural network modeling (Rumelhart & McClelland 1986), statistical learning (Aslin, Saffran & Newport 1999), data-driven corpus analysis (Bybee & Hopper 2001), embodied cognition (Barsalou 1999) and cognitive neuroscience (Edelman 1987). The goal of emergentism is the exploration of the biological and statistical mechanisms that create linguistic structure.

2. Eight core issues

Because these two paradigms have been in competition now for nearly 20 years, each has developed an internally consistent position regarding core issues in the study of language. Specifically, each paradigm has developed an approach to eight core issues. Of course, not all proponents adhere to a uniform view regarding each of the eight issues. However, across researchers and formulations, we can distinguish two competing, logically consistent approaches that provide a well-articulated approach to each of these eight issues. Let us begin by reviewing the position of UG on these eight core issues.

1. *Competence-performance.* The standard formulation of UG emphasizes the importance of basing linguistic theory on the competence of the ideal speaker-hearer, rather than diverse performances across variable speakers, situations, and dialects. This supposition of UG cannot be challenged, since it is a methodological preliminary rather than a testable empirical claim.
2. *Recursion.* The formulation of UG presented in the Minimalist Program (Chomsky 1995), emphasizes the role of recursion in characterizing the core nature of human language. Recursion involves the joining of linguistic units into a hierarchically ordered phrase structure, such as, "The man who built my house repaired Frank's car." Clauses can be recursively embedded inside other clauses, as in "The man who built the house that I sold you repaired Frank's car." It is this capacity for repeated recursion that underlies the essentially unlimited productivity of human language (Chomsky 1965).

3. *Evolution.* Because recursion plays such a central role in language structure, generative theory sees the emergence of recursion as constituting a crucial step in the evolution of human language. Moreover, this emergence is viewed as both sudden and recent. Hauser, Chomsky and Fitch (2002) distinguish the language faculty broadly defined from the language faculty narrowly defined. According to this recent account, many species have evolved special vocal forms and social support for communication, but only humans have achieved recursion. Moreover, the recent expansion of human material culture is taken as evidence that there was a recent, sudden evolution of the neural structures supporting recursion.
4. *Genetics.* UG accounts often claim that there has been a sudden, recent evolution of recursion that can be traced to a specific genetic basis for recursive control of language (Enard et al. 2002). In support of this analysis, speakers with specific language impairment (SLI) are expected to have deficits linked to this gene (van der Lely 2005).
5. *Speech is special.* Because of its general emphasis on a biological basis for language, generative theory has often been associated with the idea that, "speech is special." The idea is that processing phonemic distinctions such as that between *pin* and *bin* relies on methods that go beyond those available to nonhumans. However, the finding that chinchillas (Kuhl & Miller 1975) and even Japanese quail (Lotto, Kluender & Holt 1997) share these abilities with humans claim has tended to undercut this view. As a result, some recent formulations of the UG position on this issue (Hauser et al. 2002) place evolutionary adaptations for speech outside the language faculty narrowly defined.
6. *Critical period.* Proponents of UG have often emphasized the idea that there is an expiration date on the special gift underlying language learning and use. This gift is sufficient to support the smooth learning of language during early childhood. However, after the end of some critical period, the natural acquisition of a second language becomes difficult or impossible (Lenneberg 1967).
7. *Modularity.* UG accounts have consistently emphasized the modular composition of the grammar. Separate modules have been proposed for thematic role assignment, pronominal binding, argument chaining, and so on. In addition, large modules such as lexicon, phonology, and syntax are thought to minimize interactive communication (Fodor 1983).
8. *Poverty of the stimulus.* Analyses of language learning grounded on UG often hold that there is insufficient information in the input to the language learner to properly determine the shape of the native language (Piattelli-Palmarini 1980). Instead, language learning is guided by a rich set of innate hypotheses regarding the shape of Universal Grammar.

Emergentist studies have developed sharply contrasting approaches to each of these eight issues. Let us consider each of these alternative emergentist formulations.

1. *Competence-performance.* From the viewpoint of emergentism, the language variation revealed through performance is not something to be abstracted away. Rather, it is the core engine driving language change and much of language learning.
2. *Recursion.* Emergentist accounts also recognize the importance of recursion in supporting language productivity. However, they view recursion as arising from ancient, general-purpose mechanisms for the organization of space and action, as well as more recent systems for short-term memory storage (MacWhinney 2009).
3. *Evolution.* Emergentism stresses the gradual nature of the coevolution of language, gesture, and thought (MacWhinney 2008a).
4. *Genetics.* Emergentism points to the complexity of gene-gene interactions (Plomin & Rutter 1998) in complex systems such as human language.
5. *Speech is special.* Emergentist approaches to speech and phonological development emphasize the role of physiological mechanisms in controlling articulation (Oller 2000). They also view auditory learning as governed by basic aspects of the auditory system and temporal processing constraints (Holt & Lotto 2010).
6. *Critical period.* Emergentist accounts emphasize the gradual nature of the decline in language learning abilities over age. They attribute this decline to the entrenchment of the first language, the transfer of first language abilities, and the competition between the first and second language (MacWhinney, in press).
7. *Modularity.* Emergentist accounts emphasize interactivity between permeable, emergent modules (McClelland, Mirman & Holt 2006).
8. *Poverty of the stimulus.* Emergentist accounts emphasize the richness of the input to the learner and the role of item-based learning strategies in achieving effective learning of complex structures (MacWhinney 2005c).

Table 1 summarizes the positions of these two paradigms on these eight core issues.

Because UG is the older, more established, tradition, it has received relatively more attention, elaboration, commentary, criticism, and codification. Moreover, the logic underlying the linkage between the default UG view on each of these eight issues is generally well understood. In comparison, the logic of the emergentist approach to these eight issues has received less discussion. Therefore, we will devote the remainder of this paper to a consideration of the logic underlying emergentism.

Table 1. Positions of UG and emergentist approaches on eight core issues

Issue	UG approaches	Emergentist approaches
Competence-performance	Focus on competence	Rejection of the distinction
Recursion	Recursion is a specially evolved human capacity	Recursion arises from a network of cognitive abilities
Evolution	Language arose recently and suddenly	Language arose gradually through coevolution
Genetics	Language relies on specific genes	Language relies on general cognitive abilities
Speech is special	Speech production and audition rely on unique, recent human adaptations	Audition depends on general mammalian abilities; production is a recent adaptation
Critical period	L2 is fundamentally different from L1	L2 and L1 use the same set of abilities
Modularity	Language is processed in impermeable modules	Language processing is fundamentally interactive
Poverty of the stimulus	Language cannot be learned from the input	Language can be learned by bootstrapping from the input

3. Mechanisms of emergence

UG accounts place an emphasis on the recursive application of symbolic rules as characterizing the uniquely human capacity for language. The emergentist view counters this emphasis on innate constraints with an emphasis on dynamic, emergent processes. Some of these are the familiar processes of information-processing psychology, such as competition, strength, and reinforcement that are central to usage-based accounts such as the Competition Model (MacWhinney, in press) or Construction Grammar (Goldberg 2006). These competitive processes reflect the Darwinian emphasis on emergence from variation, adaptation, and selection (Edelman 1987). In addition, emergentist accounts emphasize the role of neurophysiological processes and constrains such as interactive activation (McClelland & Rumelhart 1981), memory consolidation (Wittenberg, Sullivan & Tsien 2002), reinforcement learning (Westermann & Miranda 2004), and a preference for short neural connections (Jacobs & Jordan 1992).

To illustrate how emergentism approaches issues in language learning, let us consider how the mechanism of entrainment or coupling can be used to account for aspects of the development of infant babbling. In 1794, Huygens demonstrated that two pendulums moving at different periods would couple together to find a single periodicity if they are mounted on a board with springs.

During this coupling, one pendulum serves as the strong attractor that entrains the other pendulum to its periodicity. This form of resonant coupling also seems to work within language learning. Studies of the mechanics of infant babbling have demonstrated that there is an early period when the child moves the jaw with a consistent rhythm (MacNeilage 1998). During babbling, the periodicity of this movement then serves to entrain a similar periodicity in the opening and closing of the glottis. The direct result of this coupling is the emergence of canonical babbling (Vihman 1996).

This simple illustration of an emergent process of language focuses on the linkage of the jaw to the glottis. However, emergent processes often function within more complex self-regulating feedback loops. For example, the Krebs cycle in cell metabolism relies on repeated catalytic reactions to construct adenosine triphosphate (ATP) for energy transfer. The cycle involves several feedback processes that make sure that ATP is not created in excess and that the original reactants (FAD and NAD+) are recreated to allow the cycle to continue. In this way, the catalytic nature of the cycle guarantees ongoing homeorhesis (stability during change) for cell construction and metabolism.

The hierarchical nature of emergent processes can be further illustrated by considering the determination of protein folding. The primary structure of a protein is determined by its sequence of amino acids, which is in turn a function of the order of amino acids in a codon of DNA. This is the structure that is directly controlled by evolutionary selection for mutations. The secondary structure of proteins involves coils, fold, and pleats that arise from the formation of hydrogen bonds between CO and NH groups along the polypeptide backbone. Tertiary structure, leading to the folding of single polypeptides, derives from hydrophobic interactions and disulfide bridges that produce bonding between side chains. Quaternary structure emerges from the aggregation of polypeptide subunits, as in the combination of four subunits in hemoglobin. Altogether "The specific function of a protein is an emergent property that arises from the architecture of the molecule" (Campbell, Reece & Mitchell 1999).

Biological systems depend heavily on *homeorhetic* systems for the preservation of life. These systems maintain balance for hormone levels, ion transport, metabolites, immune functioning, and cell growth. In language, homeorhesis operates on physiological, neurological, and social levels. Conversation itself can be viewed as a homeorhetic process in which speakers maintain the floor and confirm interaction through ongoing attentional signaling and interactional markers. Biological systems also display various types of loose coupling (incomplete penetrance, weak canalization, pleitropy) in the expression of the genetic code (Waddington 1957). Emergentists see these loose couplings as evidence for the non-modular and emergent nature of neural control of language. For

example, the KE family studied by Gopnik and Crago (1990) has an inherited dominant mutation in the Fox2P gene that has an impact on motor functioning generally, leading to problems with chewing, drooling, and articulation. These articulatory problems then result in difficulties in producing final syllables in forms such as "jumped." In this case, the primary deficit is a motor disorder which then has indirect, loosely coupled effects on some aspects of the grammar. Table 2 summarizes the various mechanisms of emergence discussed above.

Table 2. Mechanisms of emergence

Mechanism	Description
Strength	Synaptic connections grow in strength, based on usage and cue validity.
Competition	Neurons integrate across inputs, so that stronger cues dominate over weaker cues.
Reinforcement	Hebbian learning – neurons that fire together wire together.
Memory consolidation	The hippocampus supports longterm encoding of patterns with strong associations and high cue validity.
Spreading activation	The spread of activation generates associations, activates local maps and gangs, and facilitates recall.
Lateral inhibition	Within local maps, the best match comes to inhibit its competitors.
Interactive activation	Major areas communicate interactively through white matter connections.
Short connections	Local connections are preferred over more expensive distant connections. This produces a weak form of modularity.
Entrenchment	Processes of self-organization in local maps become less flexible over time, leading to decreased plasticity.
Item-based learning	Concepts and lexical items serve as centers for other learning.
Serial ordering	Concepts and lexical items specify order relations with other items.
Generalization	Item-based patterns can join into larger groups and types.
Analogy and transfer	Patterns from a first language will be transferred to second languages.
Proceduralization	Repeated use of specific serial patterns leads to automatization supported by the procedural learning system.
Coupling	Resonant communication between modules is facilitated by isomorphic mapping based on embodied codes.
Embodiment	Language adapts to the shape of the vocal tract and body.
Homeorhesis	Neural and conversational patterns continue in a constant form unless redirected.

4. Seven timeframes

Language is grounded on levels of emergent structure very analogous to those involved in protein folding or catalytic processes such as the Krebs cycle. The brain, the vocal tract, and the body are themselves biological systems that help to shape the bases for language. Just as we can distinguish levels of protein folding, we can distinguish seven markedly different timeframes for emergent linguistic processes and structures (Lorenz 1958).

1. *Phylogenetic emergence*
   The slowest moving emergent structures are those that are encoded in the genes. Changes across this timeframe – which involves millennia rather than minutes – are controlled by natural selection (Darwin 1871). The core engine of emergence is the generation of variation through mutation, followed then by natural selection through both mate choice and differential mortality. Natural selection utilizes the possibilities for reorganization shaped by the DNA and the interactions of polypeptides that it specifies. The unevenness of this underlying landscape makes some mutations more probable and frequent than others, leading to a reliance on the reuse of old forms to serve new functions. Emergentist accounts in this area have emphasized the ways in which language, society, and cognition have undergone coevolution (MacWhinney 2008a) based on the linking of dynamic systems. To trigger this coevolutionary advantage, changes in linguistic abilities must arise in parallel with advances in cognitive or social abilities. Moreover, both effects must interact at the moment of speaking. When this happens in a way that favors reproductive fitness, the mutation will be preserved.
2. *Epigenetic emergence*
   The codification of information in the DNA represents a precise meshing between the slow moving process of evolution and the faster-moving process of epigenesis (Waddington 1957). Embryologists have shown us that biological structures emerge from processes of induction between developing tissue structures in the embryo. The shape of these interactions is not hard-coded in the DNA. Instead, the DNA encodes information that can push the process of differentiation in particular directions at crucial epigenetic choice points. The precursors of autism in the embryo can be traced to particular epigenetic effects, as can the formation of stripes in the tiger. Epigenetic emergence does not cease at birth. To the degree that the brain maintains a level of plasticity, epigenetic processes allow for recovery of function after stroke through rewiring and reorganization. Before birth, epigenetic interactions with the environment are confined to forces that impinge on the

uterus and the embryonic fluid. After birth, the environment can trigger a wide variety of variations in gene expression from diabetes to brain reorganization for language in the deaf (Bellugi, Poizner & Klima 1989).

3. *Developmental emergence*
   Jean Piaget's genetic psychology (Piaget 1954) was the first fully articulated emergentist view of development. Impressively complete in its coverage, it failed to specify details regarding mechanisms of development. To provide this missing mechanistic detail, current emergentist accounts of development rely on connectionism (Quinlan 2003), embodied cognition (Klatzky, MacWhinney & Behrmann 2008), and dynamic systems theory (Thelen & Smith 1994). Emergentist theory has been used to characterize two different, but interrelated, aspects of development. The first is the learning of basic facts, forms, relations, names, and procedures. Connectionist and usage-based models of language learning, such as those that deal with learning of the past tense (MacWhinney & Leinbach 1991), syntactic patterns (Waterfall, Sandbank & Edelman 2010), or word segmentation (Monaghan & Christiansen 2010) often focus on this type of development. A second type of development involves the learning of new strategies and frameworks that can alter the overall shape of language and cognition, often through cue focusing and bootstrapping (Regier 2005; Smith & Colunga 2003).
4. *Processing emergence*
   The most fast-acting pressures on language form are those that derive from online processing constraints (MacWhinney 2008c). These pressures arise from the limitations of memory mechanisms, attentional focusing, coordination of sentence planning, code switching between languages, and motor control. When bilinguals switch from English to Spanish, the initial moments of speaking in Spanish are still under the influence English neural activation until the alternative Spanish patterns become fully active (Grosjean & Miller 1994). Many of these online pressures are themselves driven by long-term processes. For example, a child's failure to understand the meaning of the word "dependability" in a discussion of the reliability of batteries (MacWhinney 2005a) may be the result of problems in understanding previous classroom and computerized lessons on numerical distributions. Similarly, the failure in lexical retrieval that occurs in aphasia is driven by changes to neural tissue subsequent to a stroke. Thus on-line processing emergence can reflect the status of long-term developmental, neuronal, and physiological processes.
5. *Social emergence*
   Many of the pressures that operate during face-to-face conversations derive from long-term social commitments. Our choice of vocabulary, slang,

topics, and even language is determined by the status of our social relations to the people we meet. We can select particular linguistic options to emphasize solidarity, impose our power, or seek favors. The time course of these social commitments is often measured in years or decades (Labov 2001). Some basic social commitments, including those forced by gender and race, can never be fundamentally altered.

6. *Interactional emergence*
   Apart from our long-term commitments to dialects, languages, and subgroup themes, we also make more short-term commitments to ongoing social interactions. For example, we may engage a real estate agent to help us buy a house. Our linguistic interactions with this agent are then shaped by the status of the buying process. Even after we complete one set of transactions with this agent, we will maintain an ongoing relation that will then shape our further interactions, days or weeks later (Keenan, MacWhinney & Mayhew 1977).
7. *Diachronic emergence*
   We can also use emergentist thinking to understand the changes that languages have undergone across the centuries (Bybee & Hopper 2001). These changes emerge from a further complex interaction of the previous levels of emergence.

With these seven timeframes in mind, we can construct a revised interpretation of the traditional question "Is it innate or learned?" What this question really means is "Across what timeframe does this ability emerge?"

5. Why the paradigm shift?

Given the dominance of emergentist thinking in the biological and physical sciences, one may well ask why the various disciplines studying language have taken so long to explore emergentist accounts. The primary reason for this delay has been the lack of the methodological tools needed to construct and test emergentist accounts. Many of the methods needed to build an empirical basis for emergentism in language studies have only become available during the last decade. We can point to six major methodological and empirical advances that have now made emergentism accessible to wide groups of scientists.

5.1 Corpora

Perhaps the single most important advance in language studies has been the development of web-accessible corpora of language interactions through the CHILDES (Child Language Data Exchange System at http://childes.psy.cmu.edu), TalkBank (http://talkbank.org), and LDC (Linguistic Data Consortium at http://www.ldc.upenn.edu) systems. The CHILDES database provides data on first language acquisition and the TalkBank database (http://talkbank.org) provides data on second language learning. These databases include transcripts of learners' written productions, as well as spoken productions linked to audio and/or video. As these databases grow, we are developing increasingly powerful analytic and computational linguistic methods, including automatic part of speech tagging (Parisse & Le Normand 2000), dependency parsing (Sagae, Lavie, MacWhinney & Wintner 2010) lexical diversity analysis (Malvern, Richards, Chipere & Purán 2004), and other analytic routines (MacWhinney 2008b).

5.2 Multimedia

The construction of an emergentist account of language usage also requires careful attention to gestural and proxemic aspects of conversational interactions (Goldman, Pea, Barron & Derry 2007). The last few years have seen a rapid proliferation of technology for linking transcripts to video and analyzing these transcripts for conversational and linguistic structures (MacWhinney 2007). Because video can be studied across multiple time frames (MacWhinney 2005b), it is particularly useful for articulating emergentist accounts of language structure and function.

5.3 Neural network models

The rise of connectionist modeling in the 1990s led to the formulation of a wide range of emergentist accounts for language learning. At one time, running these models required days of computation on mainframe computers. Now, researchers have the power of supercomputers on their desktop and these models have become increasingly powerful and accessible. The selection of possible models has also diversified, including important alternatives such as back propagation, self-organizing feature maps, adaptive resonance, and various recurrent networks.

5.4 Imaging

Before the recent period, our understanding of neurolinguistics was dependent primarily on data obtained from brain lesions that produced aphasia. This type of data led researchers to focus on localizing language in specific modules (MacWhinney & Li 2008). However, with the advent of fine-grained localization through fMRI imaging, researchers have been able to formulate emergentist accounts of neural functioning based on the dynamic interactions of functional neural circuits. In addition, it has been possible to use ERP methodology to study competition between languages in second language and bilingual processing (Tokowicz & MacWhinney 2005).

5.5 Neuroscience

Advances in neuroscience have begun to extend our understanding of cognitive function down to the level of individual cells and local cell assemblies. Although this level of detail is not yet available for imaging methods such as fMRI, ERP, or MEG, we are learning a great deal from the study of single cell recordings in animals (Rizzolatti, Fadiga, Gallese & Fogassi 1996) and humans undergoing surgery for epilepsy. This work has emphasized the ways in which the brain encodes a full map of the body, thereby providing support for the theory of embodied cognition (MacWhinney 2008c).

5.6 In vivo learning

Until very recently, it has been extremely difficult to study the learning of second languages in actual classroom contexts. Studies of this process have been beset with problems with random assignment, relevance to educational goals, and poor control of stimuli. However, using new web-based methods (http://learnlab.org and http://talkbank.org/pslc) it is now possible to study students' learning of French, Chinese, English, and Spanish on a trial-by-trial basis as they engage in exercises over the web. These exercises are providing us with direct empirical tests regarding theories such as the Competition Model (MacWhinney, in press) and the operation of graduated interval recall (Pavlik, in press; Pimsleur 1967). We are now able to track whole terms of online student responses during French and Chinese vocabulary training, pinyin dictation for Chinese, tone discrimination, sentence repetition in Japanese and Chinese, article use in English, and the acquisition of other basic skills in second languages.

6. Conclusion

This paper has presented a comparison of two paradigms. The older paradigm of universal grammar (UG) was formulated during the dawn of the cognitive revolution in the 1950s. UG accounts have produced major advances in our understanding of language and the mind. The mechanisms envisioned by this paradigm have focused on the stipulation of rigid modules, symbolic rules, sharp critical periods, and strict genetic determination. Sensing the limitations of this paradigm, researchers have begun to formulate accounts that view language as emerging from dynamic and competitive mechanisms operating across a diverse set of time scales. Recent advances in powerful computation, modeling, corpora, imaging, neuroscience, multimedia, and online instruction have made the construction of emergentist theories increasingly accessible. Using these new tools, students of language processing will be able to build accounts of language learning that are increasingly in line with those developed in the biological and physical sciences.

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CHAPTER 2

Dynamic systems methods in the study of language acquisition

Modeling and the search for trends, transitions and fluctuations

Paul van Geert

Language acquisition is viewed as an example of a dynamic system. It consists of many components that interact with each other. The components show trajectories over time, the properties of which result from the dynamics of the interaction. A large variety of components can be taken as potential indicators of underlying mechanisms of change and acquisition. Examples of such indicators are the number of one-, two-, three- and more-word sentences, the number of spatial prepositions, and many others. These and other observable aspects may be used as stochastic indicators of underlying processes such as transitions between qualitatively distinct generative mechanisms, discontinuities, and so forth. Insights into the dynamics of language acquisition may be obtained, first, by modeling the dynamic interactions between the components at issue and by comparing qualitative properties of data simulated by those models with properties of empirical data. A second approach to obtaining more insight into the dynamics of language acquisition is by applying flexible smoothing techniques to time-serial language data and to determine the eventual changes in the amount of fluctuation in the data. Both the smoothed curves and fluctuation data can provide indirect evidence of underlying processes, such as continuities or discontinuities and regressions. The modeling, smoothing, and fluctuation techniques are primarily quantitative and should be seen as an addition to qualitative analyses.

1. Introduction

By way of introduction – and paraphrasing the famous Monty Python comedy sketch featuring a football match among Greek and German philosophers – I would like to ask the reader to imagine a tennis match between Heraclitus

(everything moves …) and Plato (the ideal essences …), with Zeno from Elea as umpire. Zeno is of course known for the paradoxes, featuring characters such as Achilles and a tortoise, presenting arguments against motion. The interesting thing about Zeno's paradoxes is that it is obvious that they are false – you can witness that by simply looking around you – but that it is very difficult (and some would still claim, impossible) to prove that this is so. But then, why would an advocate of dynamic systems theory such as the present writer, introduce at least two apparent opponents of the motion view of reality and not choose the side of the only motion theorist in the game, Heraclitus? The answer is that for a good understanding of dynamic systems as it applies to the world around us – including that little but significant thing called language and language development – we should really learn to appreciate the fact that it is not a matter of either-or, motion against essences, for instance. The answer lies in the dynamic interplay between these views, i.e. in the tennis match itself, and not in who wins the game. If all this makes very little sense to you, let us try to approach the matter from a somewhat more scientific angle of view.

2. What does dynamic systems theory entail?

If one searches the literature in developmental psychology with "dynamic systems" as a keyword, one is likely to first run against publications that define dynamic systems theory as a theory of embodied and embedded action (especially in the publications of Thelen and Smith, see for instance Thelen & Smith 1994; 1998 for overviews). In essence, cognition, thinking and action are explained as dynamic patterns unfolding from the continuous, "here-and-now" sensory-motor interaction between the person and the immediate environment.

The dynamic system at issue is the continuous coupling between the organism and its direct context, showing a time-evolution that takes the form of intelligent action, including language use, having a conversation, and so forth (for examples of applications of this view to word use and word learning, see for instance Colunga & Smith 2005 and Jones & Smith 2005; Gogate, Walker-Andrews & Bahrick 2001).

A second line of thought emphasizes that development is a self-organizing system, showing attractor states, non-linearity in its behavior, complexity, emergence, variability and so forth. The inspiration for this view comes from the study of complex dynamic systems in other disciplines, which has demonstrated that such systems indeed show the properties in question. This view has primarily focused on social interaction, emotions and personality development (Lewis 2000; Lewis, Lamey & Douglas 1999; Lewis 2005). Examples of this approach

in the field of L1-acquisition and psycholinguistics in general are Hirsch-Pasek, Tucker and Golinkoff (1996), van Orden (2002) (the latter serves as introduction to a special issue devoted to nonlinear dynamics and psycholonguistics) and Perruchet (2005). The self-organization and complexity approach has also been applied to the learning and acquisition of second language (Larsen-Freeman 1997; Larsen-Freeman & Cameron 2008; Ellis & Larsen-Freeman 2006, 2009; Herdina & Jessner 2002; Verspoor, Lowie & van Dijk 2008).

A third approach is the one that has been defended by the current author for about twenty years now, which is that dynamic systems is basically a very general, mathematical approach to describing and explaining change, focusing on the time evolution of some phenomenon of interest, and attempting to specify the principles or "rules" that describe this time evolution (for general overviews, see van Geert 1994, 2003 and van Geert & Steenbeek 2005). A recent application of this viewpoint in the field of L2-learning has been proposed by de Bot, Lowie and Verspoor (2007) and van Geert (2007, 2008). This general, mathematical approach to the time evolution of language has, so far, been most explicitly applied to the (biological) evolution of language in the human species, which of course spans an entirely different scale of time than the one that is of interest to students of language development (Kello 2004; Kirby, Smith & Brighton 2004; Nowak, Komarova & Niyogi 2001).

The differences in viewpoints are less great than one might think. The relationship between these approaches is in fact one of decreasing specification (and increasing generality). Thus, we can start from the most general definition (the third approach) and apply it to systems that are complex and sufficiently permanent, such as human beings. We will discover that these complex dynamic systems display a host of interesting properties, namely self-organization, attractor states and so forth. Thus, the application of the general approach to systems that are of interest, say, to students acquiring a second language, leads to the second approach. In order to explain the relationship with the first approach, I will have to go a little deeper into the issue of dynamics on various time scales. Take for instance the notion of a lexicon and the growth of a person's lexicon, in L1 and L2. There is no doubt that the notion of a lexicon provides a useful concept for describing an important aspect of the person's language and language development in the long run. However, the question is: what does "lexicon" mean in terms of the timeframe at which people produce and understand words in actual speech and conversations. Investigators such as the above-cited Colunga and Smith (2005), Jones and Smith (2005), and Gogate, Walker-Andrews and Bahrick (2001) have tried to answer this question by showing how the production and understanding of words emerges in a dynamic interplay between the person and a context (their work focuses on children in the first stages of word learning, but

the principle should apply to all forms of word production and understanding, also in adults). That is, they have provided a model of the short-term dynamics of word production and understanding and, by implication, of the way in which new words appear through this immediate interaction. It should be noted, however, that the meaning of concepts such as "word" depends on the level of aggregation or the dynamic time scale at which words are produced (for further discussion, see the section on Categories and Continuities).

However, one can take this short-term dynamics level for granted, and focus on the long-term time scale at which one can see the number of new words as a whole (as a lexicon) increase and finally come to a more or less stable level (which would require a time scale of at least a few years, in comparison to the time scale of seconds or minutes needed to describe the short term dynamics of actual production and understanding).

The focus on either the short- or the long-term time scale is a matter of division of scientific labor, so to speak. It is comparable to the distinction between a population biologist who focuses on the growth of populations and multiplies the number of individuals by some birth rate (the long term) versus a developmental biologist who studies the mechanism of reproduction in animals. It is clear that the population biologist's multiplication term is an abstraction, which takes the form of procreation and reproduction on the level of individual animals. Thus, the two levels of analysis can be pursued independently of one another, but in the end, the two must meet in a comprehensive theory explaining how one level links to the other.

The short-term dynamics explaining the actual production and understanding of language "on the spot" is characterized by a number of interesting properties, one of which is fluctuation and variability (e.g. Thelen & Smith 1994; van Geert & van Dijk 2002). These properties must be taken into account by any model focusing on longer-term time scales and should not be disregarded as, for instance, measurement error.

3. A somewhat more technical definition of "dynamic system"

The mathematical definition of "dynamic(al) system" is: "a means of describing how one state develops into another state over the course of time" (Weisstein 1999: 501).

Thus, if x_t is a specification of a "state" at time *t*, a dynamic model takes the form

$$x_{t+1} = f(x_t)$$

which means that "the value of x at time *t+1* is a function "f" of the value of x at time *t*". A state is described by the value of a variable (or several variables, for that matter). The change in the value is a function of the variable's current value. Thus, a dynamic systems model of lexical development on the long-term time scale will take a current level of a particular child's lexicon, for instance, 100 words at the age of 19 months, and specify the mathematical operation that describes the increase in the lexicon over some unit time (a month, for instance). That is, the next state of the lexicon (after a month) is a transformation of the current state, according to some explicit model or set of rules, which in the case of lexical growth most likely amounts to a simple multiplication term (the current author has argued that a realistic model is a little – but not really very much – more complicated than just a mere multiplication: by adding a limiting term to the model, which reduces lexical growth proportional to the level of the lexicon, one arrives at the logistic growth model, which provides a general model of lexical growth, see van Geert 1991). Note that a dynamic model is "recursive", or "iterative". That is, it describes a procedure or function (the f in the equation) that transforms x_t into x_{t+1}, x_{t+1} into x_{t+2}, x_{t+2} into x_{t+3} and so on. That is, the "output" of a preceding application of the dynamic function f is the "input" of the next application. The series of successive x's forms the description of a process and is also called the time evolution of the variable at issue (the lexicon in this example). The "f" in the equation represents a mechanism of change and is called the *evolution rule* or *evolution term*.

This example of lexical growth is very simple in that it contains only one component, namely the lexicon. In principle, dynamic systems are more complex than that, in that they will consist of a system of *coupled* components or variables. Bates and Goodman (1997), for instance have argued for a close coupling between grammatical and lexical development, which, they claimed, could eventually be described in the form of a non-linear dynamics type of coupling. Thus, let x be the lexicon and y the grammar (in a particular child, at a particular time). The coupled dynamic model would be as follows:

$$x_{t+1} = f(x_t, y_t); y_{t+1} = f(y_t, x_t)$$

stating that the next state of the lexicon is a function of the previous state of the lexicon and the previous state of the grammar; whereas the next state of the grammar is a function of the previous state of the grammar and the previous state of the lexicon. These coupled dynamic systems display all sorts of interesting properties, including S-shaped change, stepwise change, temporal regressions in the coupled components etc. Note again that these phenomena apply to a long-term time scale, comprising a time span of at least months or years. The nature of the relationships between the components that govern their dynamics over the long

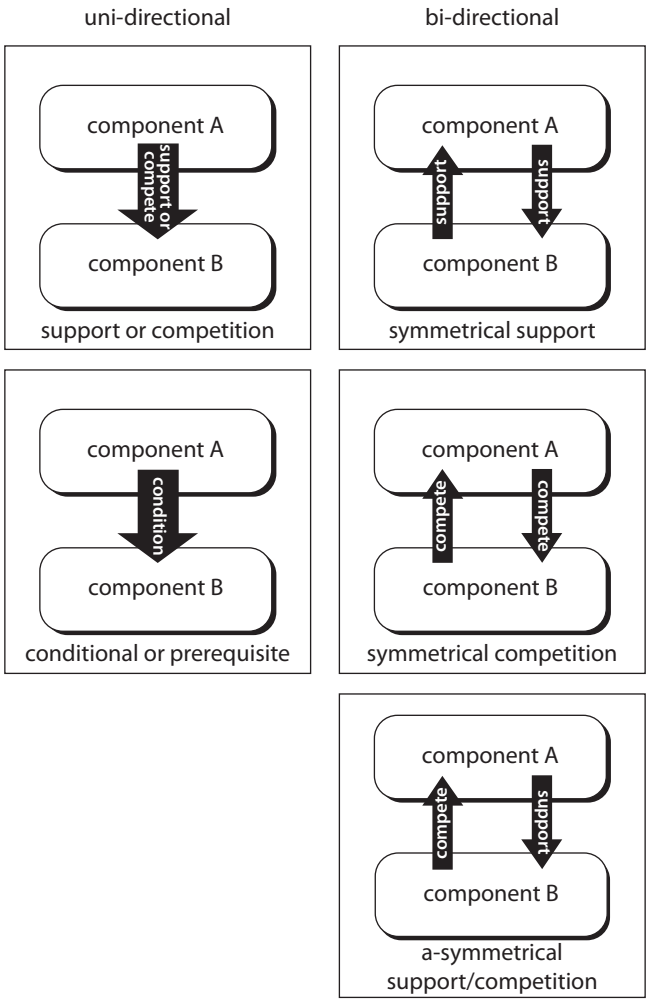


Figure 1

term of developmental time are relatively simple. They either amount to supportive, competitive, neutral or conditional relationships (see Figure 1).

A supportive relationship from lexicon to grammar, for instance, means that grammar increases (i.e. grammatical knowledge, level or competence) proportional to the size of the lexicon, meaning that greater lexicons have a stronger effect on increase in grammatical competence than smaller ones (all other things being equal). These relationships are also governed by limiting effects, which account for the fact that the magnitude of the relationship or the effect has the form of an inverted U, i.e. with an optimal effect at a particular level. In the case of the

lexicon and the grammar, the relationship is most likely positive symmetrical, meaning that the lexicon positively affects grammar and grammar positively affects the lexicon (in a forthcoming example we will see that relationships among components can be asymmetrical). By means of these simple relationships, it is possible to specify a web of symmetrical or asymmetrical influences among the components of a dynamic system, consisting of at least two, but in reality mostly of many more constituents. An example of a more complex system might comprise the relationship between lexicon, grammar, cognition, perception and communication. It is easy to imagine that such a system tends to become quite complicated. However, it is a misunderstanding that real complex systems can only be represented or explained by complex models. There are many examples – and lexical development is in fact one of those – where the real complex system shows relatively simple long-term behavior that can be represented in the form of relatively simple dynamic models. This "reduction-to-simplicity" is one of the characteristic properties of real complex systems, consisting of a myriad of underlying components (e.g. all the little biological, neurocognitive and social events that constitute the use, comprehension and learning of words). This principle is called *coordination* or *reduction of the degrees of freedom* and explains why the brain and the context for instance, both extremely complex devices, can act in unison to produce a coherent event such as having a conversation or reaching a simple action goal (Pessa 2004).

4. Categories (versus/and) continuities: A view from dynamic systems theory

Adherents of dynamic systems approaches criticize the classical cognitive science approaches for their representationalist and sequentialist stances with regard to the language and language production and development. Spivey (2007: 261), for instance, states that "… mental activity begins to look less like a string of symbols in a computer and more like a trajectory continuously worming its way through a high-dimensional state-space wherein different locations (attractors) correspond to different words, objects, and concepts." Given that languages are complex dynamic systems (Larsen-Freeman & Cameron 2008; Beckner et al. 2009), one can no longer adhere to a view of language consisting of separate modules like the lexicon and syntax, containing strictly separate constituents or components, such as words, or syntactic categories such as nouns. Instead of dealing with the classical representationalist architecture consisting of separate modules and components, complex dynamic systems deals with high-dimensional state spaces, the dimensions of which are activation levels of neurons related to the

perceptual and motor systems of the person (Spivey & Dale 2006). What counts as a categorical unit in the representationalist view, actually corresponds with temporary attractor states in the state space. An attractor state is a temporarily self sustaining correlational pattern in the state space, for instance a particular activation pattern of neurons, involving a particular loop between perception and action. Words or syntactic categories emerge out of this dynamic processes, a point of view which is quite similar to earlier emergentist and functionalist approaches to grammar (e.g. Hopper 1996, 1997).

In contrast with the discreet view on categories, complex dynamic systems approaches to language propose a gradualist view. For instance, linguistic constituent structure can gradually emerge from non-linguistic processes, such as perceptual chunking and categorization (see for instance Beckner & Bybee 2009).

The question is: should we discard concepts such as "word", "syntactic rule", "noun", and so forth, in favor of a terminology that emphasizes trajectories in state space and the temporary construction of attractor states that continuously evolve into other attractor states (Spivey 2007)? My answer to this question is that a complex dynamic system has various layers of organization, and, in fact, one of the characteristic properties of complex dynamic systems is that these layers of organization self-organize as a result of the systems dynamics. Hence, the complex dynamics of language and cognition as a real-time dynamics, should be described in the form of neural state spaces and ephemeral attractor states. However, these real-time dynamics show a long-term evolution ("long-term" defined as ranging from the duration of a communicative interaction between persons to the duration of language development or even language evolution), characterized by higher order properties, such as correlational patterns between the system's attractor states, that can best be described in the form of categorical terms such as "word" or "noun category". That is, complex dynamic systems such as language-using human beings, require a form of pluralistic description that takes the variety of organizational levels and time scales into account (Dale 2008a, 2008b; van Geert & Fischer 2009), and thus that recognizes that concepts such as "word" or "noun" have quite different meanings on the level of real-time processes than on the level of long-term processes or dynamics. Although the real-time and long-term process levels are reciprocally linked (events on the real time level have an effect on long-term processes, and long-term processes, for instance of development and learning, have an effect on real-time processes), the mechanisms operating on both levels should not be confused. Thus, a typical representationalist analysis of language production would probably place words and syntactic categories at the beginning of the causal chain corresponding with the real-time process, for instance by positing a mechanism that draws words from a lexicon based on slots in some syntactic framework, and then assigns a phonological interpretation to

the structure. Although I'm not claiming that any cognitive or representationalist view of language production actually follows this simple model, the explanations offered by classical cognitive or representationalist accounts of language are probably closer to this scheme than to the scheme of dynamic systems explanations.

If concepts such as "word" or "noun" are descriptively adequate on the complex dynamic system's higher order level of organization, they can feature in causal or dynamic process models specified on the level of organization at which these concepts make sense (under the assumption of the descriptive pluralism as described above, see Dale 2008a, b). That is, at the descriptive level at which, for instance, the notion of "lexicon" makes sense, one can apply a dynamic systems model of lexical growth, the mechanisms of which feature on the descriptive level in question. It would be a mistake, though, to confuse these mechanisms with the mechanisms that feature on another level organization and time scale, for instance that of the real-time level of word use or production.

In short, complex dynamic systems such as language, require Heraclitus as well as Plato, and Zeno to remind us of the complexities that arise where Heraclitus and Plato meet, warning us that both should be taken seriously but not too literally.

5. Dynamic uncertainties …

Needless to say, however, that the reciprocal relations between mechanisms and process descriptions on different time scales – real-time language production and long-term language development – are as yet far from clearly understood. Whereas it is relatively easy to take some higher-order property such as "lexicon" or "grammar" and look at its long-term evolution, the short-term dynamics requires an understanding of a great many lower-order components or constituents, hidden deep down in the brain and scattered over the many aspects of a concrete here-and-now context of actual speech production. Attempts to understand this dynamics come from fields such as neurocognition, but also from connectionist modeling (Ellis 1998; Elman 2001; Thelen & Bates 2003; Spivey & Dale 2006) and from the embodied-cognition approach to dynamic systems which was discussed earlier. These short-term dynamics amount to what Thelen and Smith (1994), in accordance with Haken (1999), have called a soft-assembly process. That is, the psychological and linguistic variables that we perceive as constituents of a person's actions are not fixed and permanent units, but are dynamically assembled if needed. Whether or not this soft-assembly notion is the best possible explanation of the status of, for instance, linguistic components and constituents such as words, phrases or grammatical structures, it is nevertheless consistent with the idea that language and language development for

that matter is a complex and dynamic phenomenon, which has the properties of Heraclitus ("Everything moves") as well as those of Plato (the ideal essences), which, in an apparently paradoxical sense, are superposed onto each other. Consequently, any student of language development is likely to be confronted with phenomena such as non-linearity (consequences are not always proportional to their causes…), mutuality in influences (A is causally affecting B and B is causally affecting A), fuzziness, ambiguity, uncertainty and variability within and between persons.

As researchers, we are used to – and also have been trained to – treat fuzziness, ambiguity, uncertainty and variability as the consequence of absence of information, and thus as properties that will wane or disappear as soon as we get a better access to the phenomenon under study. This belief is based on the idea that, in essence, things are clearly defined and crisply segregated from one another and that the problems are caused by the incompleteness of our senses, i.e. the limitations of testing or observation (the Platonic stance). For instance, when transcribing a language corpus of a young child, it might be difficult if not impossible to decide whether a particular utterance consists of one or two words, or whether a word is in fact a verb or a preposition, or something else. It is possible that there is no way to ever decide about this, but the problem is considered one of measurement error, stated against the backdrop of a belief that in fact or in reality, the utterance contains either one word or two, or that the word is in fact either a verb or a preposition or something else, but not everything at the same time. However, from a dynamic systems point of view – given the dynamic and complex nature of the phenomena under study – properties such as fuzziness, ambiguity, uncertainty and variability within and between persons are not due to failures of knowledge but are intrinsic and characteristic properties of the phenomena themselves, and this is particularly true fro phenomena "under construction", i.e. in the process of development. Hence, it is closer to the truth to state that in this particular developmental context and moment, the utterance is one and two words at the same time, or that a word is both a verb and a preposition, to the extent that such categories are applicable at all.

Of course, a standpoint like this one seems to open the floodgates of utter confusion, paradoxes and untestable statements. However, this conclusion is premature. If fuzziness and the like are properties of a certain developmental reality, then it must be possible to study and for instance also quantify these properties in a way that is common practice in science. In a series of articles, Marijn van Dijk and I have presented various possible solutions to quantifying fuzziness, ambiguity, uncertainty and variability in language development and to use it as evidence of underlying developmental processes (van Geert & van Dijk 2002, 2003; van Dijk & van Geert 2005, 2006). For instance, in one study (van Dijk & van Geert 2005)

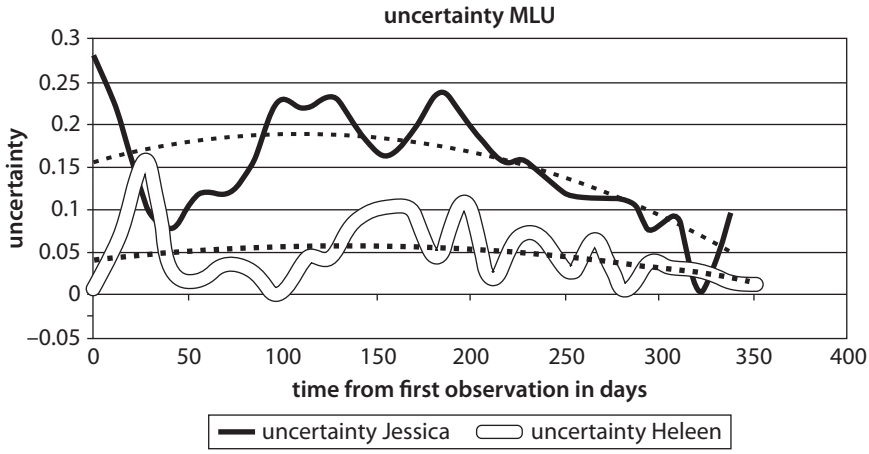


Figure 2

we applied so-called what-if scenarios to count uninterpretable or problematic utterances. For instance, if it is unclear whether a particular utterance contains one or two words, one can ask "what if it is one" (the strict condition) or "what if it is two" (the loose condition). By applying these scenarios systematically to all word counts, one obtains an estimation of a range of possible word counts (e.g. MLU) under various scenarios (it goes without saying that these scenarios must be sufficiently defendable from a linguistic and developmental point of view; the most important thing is that the same range of scenarios of interpretation is used throughout a child's developmental history and across different children). We have used the width of this range as an estimation of the ambiguity or fuzziness of the child's language production and found, first, that, within a single corpus, it changes over developmental time and, second, that it shows marked differences among children (see Figure 2).

The latter findings led us to the assumption that such differences in ambiguity are related to different styles or strategies of language development, i.e. of differences in the dynamics of language construction. In short, properties such as fuzziness or ambiguity can be conceived of as "fingerprints" or indicators of a self-organizing or emerging system or a system under transition. In the next chapter I shall give an example of how these properties, but (intra-individual) variability in particular, can be used in the study of the dynamics of early language development.

6. Transitions in early language development: A case study

6.1 The nature of generating mechanisms?

In a study that I carried out with Dominique Bassano, an attempt was made, first, to find empirical evidence for transitions in early grammatical development and, second, to dynamically model the long-term changes in language production (the whole story is rather complicated, and for details I refer to Bassano & Van Geert 2007). The model that we wished to check goes back to a hypothesis that has been around for almost thirty years now and that assumes that, in the construction of a genuine syntactic language, children begin with a stage in which one word expresses a complex referential meaning. That is, the generating mechanism of language produces single-unit expressions that refer to whatever state of affairs the child needs to refer to and is therefore called the holophrastic generating mechanism. In a second stage, the child combines these complex holophrases into utterances consisting of a few (two or three) such units, and thus generates language by means of combination, hence the stage of the combinatorial generating mechanism. While combining words, children become sensitive to the way the ambient language combines its words, which is more than just combining and involves the use of syntax (order rules, word correspondence etc.). Thus, the third and final stage in this respect is the stage at which language is based on a syntactic generating mechanism.

The term "generating mechanism" might bear a confusing association to "generative" in generative linguistics. By generating mechanism, I mean any form of complex dynamic system that generates, i.e. brings about in real-time, a particular type of language production. The generating mechanism should not be confused with a naïve representationalist model of language production, which refers to words as universal categories (present in both the child and the linguistic observer), and to rules for combining these words into sentences. According to this naïve representationalist model, the holophrastic stage is assumed to be governed by rules like "take a word from the lexicon; utter the word", and the combinatorial stage by rules like "take two words from the lexicon; determine their order; utter the two words as one sentence". This is not the type of model that I would endorse. What I mean to say is that, although the details are not known, the three stages correspond with different attractor states in some multidimensional state space, the exact properties of which we also do not really know. These attractor states can be variable and have fuzzy boundaries, and in that sense, be very different from neatly distinguished categories or rule systems. The fact that linguistic observers think they recognize a single word in the child's single word utterances, does not imply that single words must form the constituents in the child's generating

mechanism, nor that if the child produces an utterance in which the observer recognizes a combination of two words, the child must have literally used these two words as separate building blocks. In addition, it is not even necessary to assume that the child's utterances are based on some specific underlying production mechanism, such as a little holophrastic machine that spawns out single word utterances. It is likely, and empirically plausible, that the language production mechanism often follows a simple iterative principle, namely that the next utterance resembles the preceding one in the way it has been constructed (see for instance the matching principle, described by Lieven, Salomo & Tomasello 2009).

The three hypothesized stages are a prime example of fuzzy states (provided the three stages indeed exist). They occur in the form of overlapping waves and are not strictly separated from one another. The alternative hypothesis is that language development is a continuous process (whatever the exact nature of the underlying continuous processes).

First, if there are three such stages, there must be evidence of stage transitions that cannot be explained by a continuity hypothesis. This evidence takes the form of rapid changes in the form of the child's language properties, but can also be found in the form of quantitative indicators of transitions, more precisely in the form of a confluence between rapid change and temporarily increased fluctuation or variability (e.g. fluctuation in sentence length that is greater than average; note that fluctuation or variability must be defined in such a way that it can be measured independently of growth rate, otherwise the argument would be circular; for statistical and technical details see Bassano & van Geert 2007).

Second, if there are three stages and two transitions, it must be possible to model the long-term evolution of the linguistic expression of these stages, in the form of a dynamic model of stage-wise development. Of course, if the data show evidence of two transitions and can be modeled in the form of stage-wise development, we do not yet have a proof for the fact that the stages are indeed those that we postulated. What we do know is that given such evidence, it has become harder to defend the hypothesis that the developmental trajectory is in fact continuous.

6.2 Data and method

The main set of data used in this study came from the longitudinal corpus of one French girl, Pauline, who was studied from ages 1;2 to 3;0. Additional data are from another French child, Benjamin, who was studied from age 2;0 to 3;0 (see for analyses of the children's language development Bassano 1996, 2000; Bassano, Maillochon & Eme 1998; Bassano et al. 2004). Data were obtained using a free

speech sampling method. For each child, frequencies of one-word, two-words, three words utterances, etc. (W1, W2, W3, etc.) were calculated, for each monthly sample (120 utterances) and for the sub-samples (60 utterances and 30 utterances respectively). Figure 3 shows the smoothed curves of the raw data, based on a Loess smoothing procedure (locally-weighted least-squares smoothing), which provides a representation of the changes in the sentence frequencies and is able to capture eventual temporal regressions, accelerations in the growth rate etc.

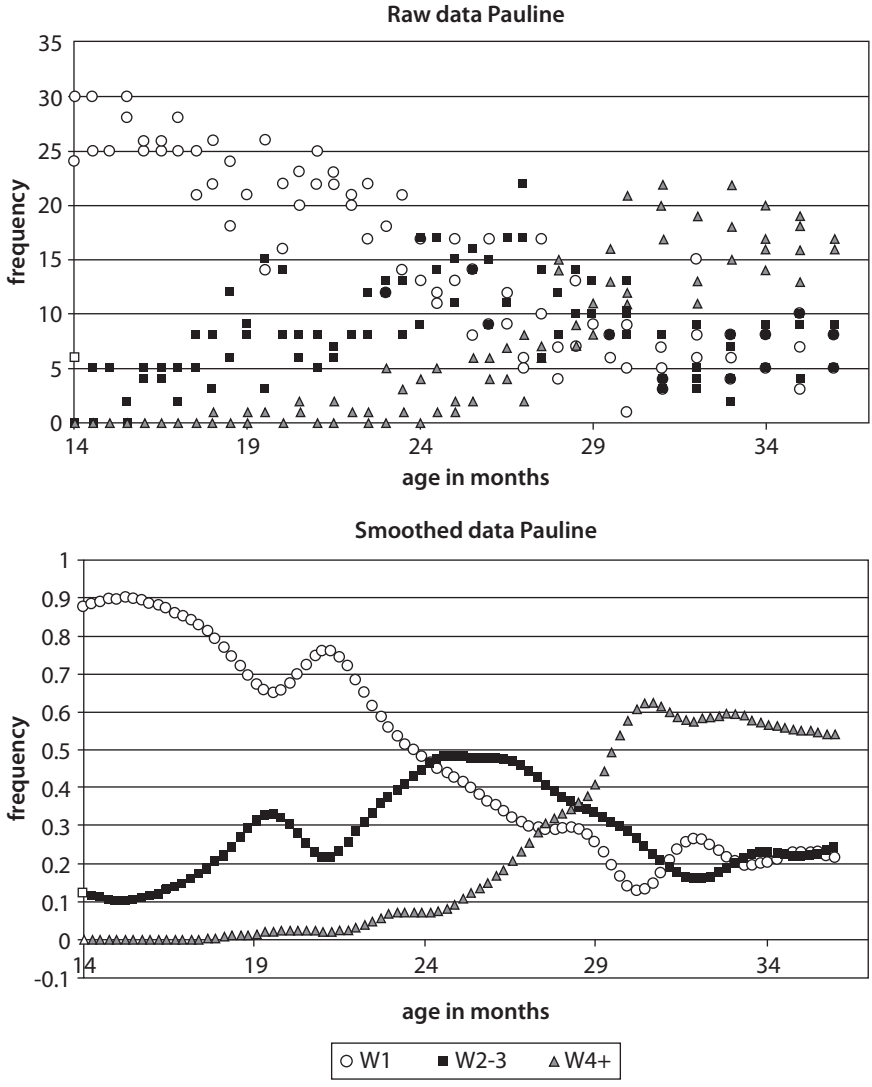


Figure 3

6.3 Evidence of stage transitions?

The first type of evidence for a stage transition concerns the occurrence of increased fluctuation at the time a transition is supposed to take place. Note again that the transition is not an all-or-none question. The generators are assumed to represent fuzzy, soft-assembly states that occur in the form of overlapping waves (i.e. there will be times where two or more generators are simultaneously present and operational). Nevertheless, the transition can amount to a change in the dominant generator mode, which is then likely to co-occur with temporarily increased fluctuation. Fluctuation is the difference between percentages in W1, W2-3 and W4+ sentences between observation sessions or within observation sessions (i.e. by comparing the first with the second half of the session, for instance). An alternative definition is that it is the difference between the expected frequency (which is given by the smoothed curves) and the observed frequency (the raw data). By plotting the fluctuation across time (ages in months), we found two peaks in the variability that coincided with rapid growth in the W2-3 sentences (assumed to correspond with the combinatorial generator) and with rapid growth in the W4+ sentences (assumed to correspond with the syntactic generator). The difficult part of the exercise was to show that these peaks were not artifacts. First, they can be an artifact of the rapid change itself, or they can be statistical artifacts (explainable as mere random distribution effects). By running statistical simulation tests, we found that the two variability peaks were unlikely to be the result of either of these statistical artifacts. Thus, there is an empirical indication of two transitions. Analyses of the linguistic properties of the child's utterances corroborated the hypothesis that during the postulated transition moments something special was indeed going on.

A second and different approach to the verification of the underlying stage model and the associated transitions, is to try to model the data by means of a stage-wise dynamic growth model. This model does not explain the emergence of a new generating mechanism out of an old one. In order to do so, a different type of model would be required. What it does is to provide a model of the way the three supposed generating mechanisms interact with each other over time and by doing so determine the quantitative characteristics of their temporal trajectory. In line with comparable growth models, we postulated that the hypothesized generating mechanisms were characterized by bi-directional asymmetric relationships (see Figure 1). The relationships are, from the less advanced to the more advanced generating mechanisms, supportive and conditional (e.g. the holophrastic generator supports the growth of the combinatorial generator and is itself conditional to the emergence of the combinatorial generator; a similar logic applies to the relationship between the combinatorial and syntactic generator). The relationship

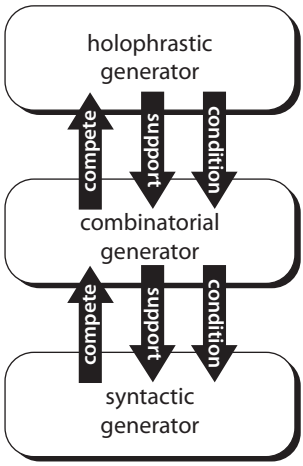


Figure 4

postulated from the more to the less advanced generator is a competitive relationship, i.e. the increase of the more advanced generator causes a decrease in the less advanced one[1] (see Figure 4).

After specifying a mathematical model that describes the bi-directional asymmetrical relationships just explained, a parameter optimization program was run that estimates the best possible set of parameters, i.e. the set for which the model produces the best possible fit with the data. Figure 5 shows the result of this optimization procedure, showing that the model provides a good fit with the data.

Note that, since the fluctuation is great, the fit is least satisfactory during the hypothesized transition points, simply because the fluctuation is greatest at those points. Hence, the dynamic model of step-wise growth provides a good overall fit of the data, but fails to capture additional underlying phenomena, such as the transition from one dominant mode to another.

Both the search for variability peaks and the dynamic modeling have been carried out with the data from Pauline and from Benjamin, although the present discussion is limited to the Pauline data only. Benjamin's data, which covered a shorter time span, corroborated the findings from Pauline. Note again that the

1. Note that since we worked with proportions of sentence types relative to a fixed number of observed utterances, the increase in one type automatically causes a decrease in another type. However, this is not what we mean by a competitive relationship between the underlying generating mechanisms. If one mechanism grows stronger at the cost of others, it will generate more utterances of its own type, relative to utterances of the other types. This will lead to a relative increase of one type and the reduction of another, which is the result of a competitive relationship between the mechanisms and, of course, not the competition itself.

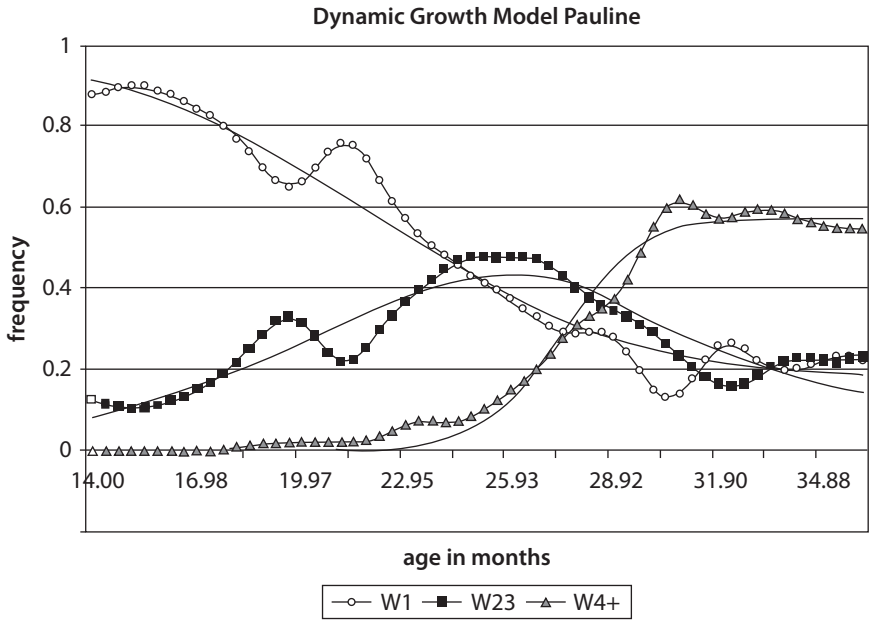


Figure 5

finding of evidence for transitions and stage-wise development does not in itself show that the hypothesized generators are indeed those that explain the child's evolution of utterance length. Other, for instance more linguistically oriented analyses are needed in order to provide additional evidence for this theory.

7. Conclusion

The dynamic systems approach to language development is not a replacement for linguistic analysis and linguistic theory formation. In the tennis match between Heraclitus and Plato, it plays the part of Heraclitus, but it can only play it if there is a second player. The second player is not so much the party that has to be defeated, but it is the party that sends the ball, which is then bounced back in a game that results in a deeper understanding of the complex phenomenon of language development. Applying a dynamic systems approach requires a considerable level of "epistemological resistance", if not immunity from the researcher. Fuzziness, ambiguity and fluctuation are part and parcel of complex, developing systems. They should not be reasoned away, but in fact be quantified and taken as evidence of development. Interacting time scales make the image even more complicated, but as long as the researcher keeps an eye open on the properties that are really

characteristic of developing language, a dynamic systems approach may offer a promising new avenue for a clearer understanding of the underlying mechanisms and processes.

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CHAPTER 3

Early bootstrapping of syntactic acquisition

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Infants acquiring language have to learn about the lexicon, the phonology, and the syntax of their native language, among others. For each of these domains, being able to rely on knowledge from the other domains would simplify the learner's task. For instance, having access to words and their meaning should help infants to learn about syntax, but learning about the meaning of words would be greatly facilitated if infants had access to some aspects of syntactic structure (Gleitman 1990).

This chapter focuses on how phrasal prosody and function words may interact during early acquisition. Experimental results show that infants have access to intermediate prosodic phrases (phonological phrases) during the first year of life, and use these to constrain lexical segmentation. In addition, by two years of age they can exploit function words to infer the syntactic category of unknown content words (nouns vs verbs) and guess their plausible meaning (object vs action). We speculate on how infants may build a partial syntactic structure, the 'syntactic skeleton', by relying on both phonological phrase boundaries and function words, and present adult results strengthening the plausibility of this hypothesis.

1. Introduction

Children learning their mother tongue are faced with a difficult task: they have to acquire the phonology of the language, construct their vocabulary and discover the syntactic rules governing the organisation of words within sentences. For each of these domains, being able to rely on knowledge from the other domains would simplify the learner's task. For instance, since syntax spells out the relationship between the words in sentences, it makes sense to assume that infants need to

have access to words and their meanings in order to learn about syntax. Conversely, learning about the meaning of words would be greatly facilitated if infants had access to some aspects of syntactic structure (Gillette, Gleitman, Gleitman & Lederer 1999; Gleitman 1990). These potential circularities can partially be solved if infants can learn some aspects of the structure of their language through a low-level, purely phonological analysis of the speech input they are exposed to (the phonological bootstrapping hypothesis, see Morgan & Demuth 1996).

In this chapter we will concentrate on the beginnings of language acquisition, more specifically that of syntax. In particular, we examine the role of two sources of information to which very young infants may plausibly have access: phrasal prosody and function words.

Prosody can be defined as the rhythm and melody of an utterance. The prosodic bootstrapping hypothesis postulates that children may use the prosodic characteristics of sentences to learn certain aspects of their mother tongue, particularly its syntax (Christophe, Guasti, Nespor & van Ooyen 2003; Gleitman & Wanner 1982; Morgan 1986; Nespor, Guasti & Christophe 1996). We focus on intermediate prosodic units, phonological phrases: these units depend on the syntactic structure of sentences and characteristically contain one or two content words along with the function words associated with them (Nespor & Vogel 1986). Phonological phrases are characteristically marked by final lengthening and strengthening of the initial phoneme. They tend to have a single intonation contour per phonological phrase with a possible discontinuity of the F0 contour at the juncture of two units (cf. Shattuck-Hufnagel & Turk 1996, for a detailed review).

The second source of information, function words and morphemes, are grammatical elements such as articles, pronouns, auxiliaries, and conjugation endings. Children may discover them in the speech signal relatively easily because they are extremely frequent syllables generally appearing at the boundaries of prosodic units. These function words also have acoustic, phonological and statistical characteristics that children could use to extract them from sentences and differentiate them from content words (Shi, Morgan & Allopenna 1998; Gervain, Nespor, Mazuka, Horie & Mehler 2008; Hochmann, Endress & Mehler 2010).

These two sources of information, phrasal prosody and function words, may be integrated in a model of language acquisition (Christophe, Millotte, Bernal & Lidz 2008, see Figure 1). Starting from the bottom, this model claims that children are able to construct, on the basis of the acoustic signal, a pre-lexical representation that is segmented into prosodic units. Prosodic boundaries are perceived by young infants (see e.g. Gerken, Jusczyk & Mandel 1994; Soderstrom, Seidl, Kemler Nelson & Jusczyk 2003; Nazzi, Nelson, Jusczyk & Jusczyk 2000), and have been shown to be interpreted by infants as word boundaries (Christophe,

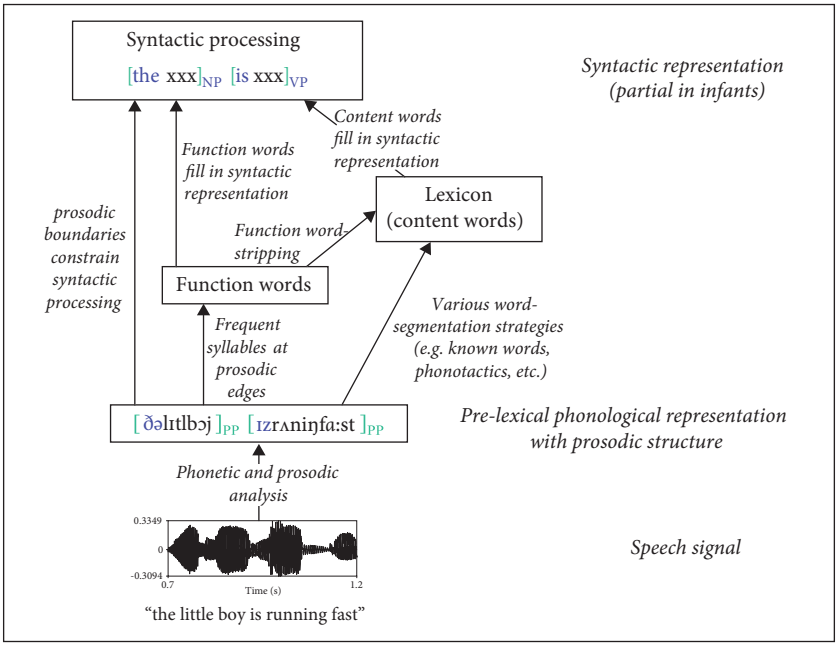


Figure 1. A model of language acquisition by infants and speech perception by adult speakers (adapted from Christophe et al. 2008).

Gout, Peperkamp & Morgan 2003; Gout, Christophe & Morgan 2004; Millotte, Margules, Dutat, Bernal & Christophe, in press). In addition, they may be directly used to constrain the syntactic analysis of sentences (we will discuss this in the first part of this chapter). In this pre-lexical representation, the most frequent syllables at the boundaries of prosodic units may be extracted from the signal and integrated into a lexicon of functional elements (Christophe, Guasti, Nespor, Dupoux & van Ooyen 1997; Shi & Gauthier 2005; Shi, Cutler, Werker & Cruickshank 2006). This special lexicon may itself inform the syntactic processing of sentences, if infants are able to figure out co-occurrence relationships between functional elements (Soderstrom, White, Conwell & Morgan 2007; Santelmann & Jusczyk 1998), and/or between functional elements and content word categories (an aspect we will examine in the second part of the chapter). Our working hypothesis is that children may construct a first-pass syntactic structure of the sentences they hear by using prosodic cues and function words simultaneously: prosodic boundaries would be used to identify the boundaries of syntactic constituents, while function words would be used to label these syntactic units (noun phrase vs verb phrase, for instance). For instance, upon hearing the sentence "the little boy is running fast", the child may create an initial syntactic representation

of the kind "[the XXX]$_{NP}$ [is Xing X]$_{VP}$" in which syntactic boundaries would be supplied by prosody while syntactic labels (noun phrase, verb phrase) would be supplied by function words and morphemes (perhaps especially those placed at the edges of prosodic units). This initial syntactic representation, or 'syntactic skeleton', could be constructed even without knowing the content words making up the sentence (in our example these words are represented simply as syllables in the form of Xs). This hypothesis will be developed and tested in the third part of this chapter.

2. Phrasal prosody constrains syntactic analysis

The first source of information crucial to the model is phrasal prosody. Since phonological phrase boundaries are aligned with the boundaries of syntactic constituents. It thus makes sense to assume that they may be used to constrain the syntactic analysis of sentences, not only by children, but also by adults. To test this hypothesis (corresponding to the direct arrow between the pre-lexical phonological representation and the syntactic representation, on the model in Figure 1), we used homophones that may belong to two different syntactic categories to create temporarily ambiguous French sentences, such as:

Adjective sentence: "[le petit chien **mort**][sera enterré][demain]…"
*The **dead** little dog will be buried tomorrow*
Verb sentence: "[le petit chien][**mord** la laisse][qui le retient]…"
*The little dog **bites** the leash that ties him*

In these sentences, the first four words are pronounced in the same way, and the only way to figure out whether the fourth word is an adjective (*dead*), or a verb (*bites*) is to process the phonological phrase boundary, that is placed just before the ambiguous word when it is a verb (in the second sentence), and just after when it is an adjective (in the first sentence). These sentences were recorded by naïve speakers who were unaware of the ambiguities in the sentences. They were then cut at the end of the ambiguous word and presented to French adults in a sentence-completion task (subjects heard the beginnings of the sentences and had to complete these in writing). Results are shown in Figure 2.

We observed that participants were able to distinguish the beginnings of these sentences that differed only in their prosodic and syntactic structures. The sentence beginnings with adjective prosody were completed significantly more often with adjectives than with verbs, and vice-versa (Millotte, Wales & Christophe 2007). The results were confirmed with an on-line word-detection task (Millotte, René, Wales & Christophe 2008). These experiments thus show

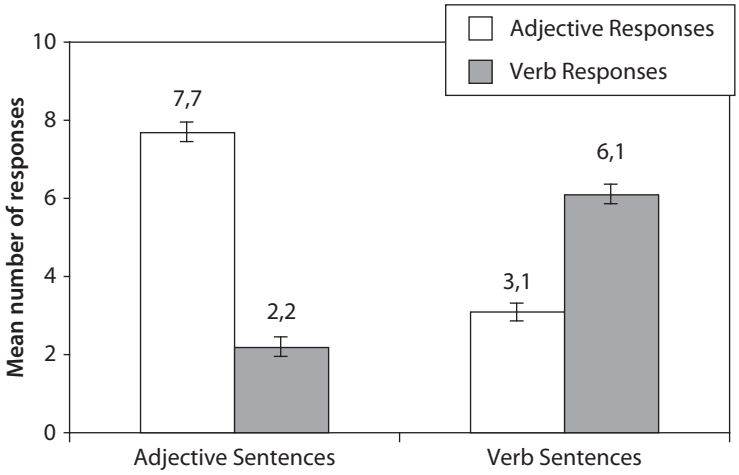


Figure 2. Results of a sentence completion experiment in which participants listened to the beginnings of ambiguous sentences cut just after the ambiguous word. Subjects gave more adjective interpretations when listening to the beginning of adjective sentences and more verb ones when listening to verb sentences (adapted from Millotte et al. 2007).

that the boundaries of phonological phrases are spontaneously produced, interpreted on-line as syntactic boundaries, and used to guide the syntactic analysis of sentences. They lend support to the hypothesis that phrasal prosody can constrain syntactic analysis on-line, as shown by the direct arrow going from the pre-lexical phonological representation with prosodic boundaries to the syntactic representation, in the model of Figure 1.

3. Function words signal the syntactic category of the following content words

Once prosodic boundaries are identified interpreted as syntactic boundaries, children have to label the resulting units. To do so, they may use function words. For instance, a unit starting with an article is a noun phrase (or, part of a noun phrase). This supposes that the children have already identified a list of function words in their own language, a hypothesis supported by the results of several studies (Hallé, Durand & de Boysson-Bardies 2008; Shafer, Shucard, Shucard & Gerken 1998; Shi & Gauthier 2005; Shi et al. 2006). In addition, they must also have learned the links between categories of function words and categories of content words (between articles and nouns, for example, or between pronouns and verbs). Several studies have already shown that infants are able to associate

articles with nouns from the age of 14 months on (Höhle, Weissenborn, Kiefer, Schulz & Schmitz 2004; Kedar, Casasola & Lust 2006; Shi & Melançon 2010; Zangl & Fernald 2007). For instance, infants orient faster towards a known object if the noun representing that object is appropriately preceded by an article (e.g. 'Where's the *book*?') than if it is incorrectly preceded by an auxiliary or a non-word (e.g. 'Where's po *book*?') (Kedar et al. 2006; Zangl & Fernald 2007). However, these studies did not show any ability to associate pronouns with verbs (see Höhle et al. 2004; Shi & Melançon, in press), and researchers have suggested that infants may find it harder to link pronouns with verbs, for two main reasons: firstly, the co-occurrence of pronouns and verbs may be less frequent than that of articles and nouns; and secondly, verbs typically represent actions, which are conceptually more complex than objects.

To test whether infants may also be able to link pronouns with verbs, we trained 18-month-old French infants to turn their head for a known word, either a noun (e.g. 'une balle' *a ball*), or a verb (e.g. 'il mange' *he eats*). In a second session, infants were tested on short sentences belonging to three experimental conditions: in *grammatical* sentences, the target word appeared in a syntactically appropriate context (e.g. 'la **balle** est rouge et verte' *the **ball** is red and green* for the noun target, or 'je **mange** une petite pomme' *I **eat** a small apple*, for the verb target); in *ungrammatical* sentences, we exchanged noun and verb targets, so that they now occupied an incorrect position, corresponding to a word from the other syntactic category (e.g. 'je **balle** une petite pomme' *I **ball** a small apple* vs 'la **mange** est rouge et verte' *the **eat** is red and green*'); last, in distractor sentences, the target word did not appear at all (e.g. 'la **fraise** est très bonne' *the **strawberry** is really good* vs 'Tu **donnes** des cadeaux à ton frère' *you **give** gifts to your brother*).

The results showed that 18-month-olds responded significantly more often when the target appeared in a syntactically appropriate context, than when it appeared in an inappropriate position. In fact, infants did not respond significantly more often to sentences that contained the target in an inappropriate position, than to sentences that did not contain the target at all. They behaved as if they considered this target as an entirely new word, e.g. the verb 'baller' (*to ball*), or the noun 'la mange' (*the eat*), having nothing to do with the target word they were trying to identify. In addition, there was no asymmetry between nouns and verbs. This result thus suggests that 18-month-old French infants already know (some of) the contexts in which nouns and verbs occur in French. They expect known nouns and verbs to occur in contexts appropriate to their syntactic category, and treat items that occur in wrong contexts as different words. This results lends support to the hypothesis that infants may exploit function words to label prosodic units.

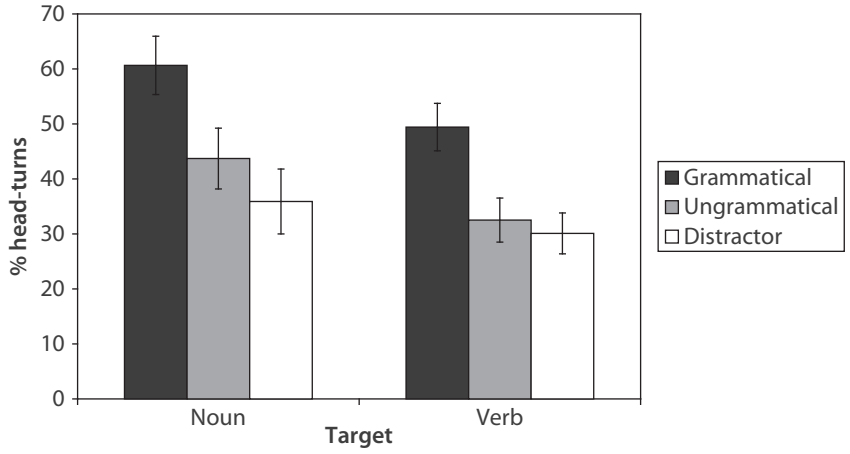


Figure 3. Results of a word-detection experiment with 18-month-old French infants trained to turn their head for either a noun (left-hand bars) or a verb (right-hand bars). In both cases, infants responded significantly more often when the target appeared in a syntactically appropriate context (grammatical sentences), than when it appeared in a syntactically inappropriate context (ungrammatical sentences) or did not appear at all (distractor sentences; adapted from Cauvet, Alves Limissuri, Millotte, Margules & Christophe 2010).

In a follow-up experiment with evoked potentials, we showed that at the age of 2 years, French toddlers exhibited differential brain responses to nouns and verbs that appeared either in appropriate or inappropriate contexts (Bernal, Dehaene-Lambertz, Millotte & Christophe 2010). Interestingly, in this experiment, we controlled transition probabilities between pairs of words by relying on the ambiguity between definite articles and clitic objects that exists in French (as in other romance languages, and several other languages). Thus, the verb 'mange' / *eat* appears in a correct context in 'je la mange' / *I eat it*, but in an incorrect context in 'je prends la mange' / *I take the eat*. Correspondingly, the noun 'fraise' / *strawberry* appears in a correct context in 'je prends la fraise'/ *I take the strawberry*, but in an incorrect context in 'je la fraise' / *I strawberry it*. Even though this ambiguous function word 'la' (meaning *the* or *it* depending on its syntactic context) should make things harder for children, 2-year-olds clearly distinguished between correct and incorrect contexts. This suggests that by the age of 2 years, their knowledge of these function words of French is already fairly refined. In addition, these results were replicated in an experiment in which the nouns and verbs had just been learnt by toddlers, and had never been heard before in the test contexts (Brusini, Dehaene-Lambertz & Christophe 2009).

In an attempt to figure out what kind of computation may allow young infants to discover in what contexts words are supposed to occur, we built a model that computes transition probabilities between triplets of adjacent words. In order to simulate an infant with little knowledge to start with, and to take advantage of the fact that functional elements are so much more frequent than content words, this model started out with only two abstract categories, nouns and verbs. All other items were not categorized a priori, but represented as themselves. For instance, the word 'un'/*a* would be alone in its category, UN. The model thus had no a priori knowledge that there are classes of function words. However, since each of these functional elements is extremely frequent, they may well appear often enough in trigrams to remain informative. In a first step, the model was trained on an (irrealistic) training corpus where all nouns and verbs were correctly categorized: in this condition, the model achieved a performance of about 90% accuracy on a test corpus, for forced-choice noun/verb categorization, suggesting that trigrams do contain significant word category information, even when functional elements are not categorized. Interestingly, when the training corpus was made more psychologically plausible by assuming that the infant/model only knew the category of the most frequent nouns and verbs of the training corpus (corresponding to the 5 most frequent nouns, and just one very frequent verb), the performance of the model went down but remained acceptable, around 75%. These results suggest that infants may be able to initially group words together on the basis of their immediate contexts. This first categorization would serve as a basis for further syntactic acquisition. Similarly, Toben Mintz proposed that young infants may focus on 'frames', pairs of non-adjacent words that frequently co-occur (Mintz 2003; Chemla, Mintz, Bernal & Christophe 2009). For instance, the frame 'you X it' selects exclusively verbs. It is thus possible that infants may start out categorizing nouns and verbs by paying attention to their immediate contexts.

Once infants know in what syntactic contexts nouns and verbs are supposed to occur, they can exploit this knowledge to assign a syntactic category to new words that have not been heard before. They can then use the syntactic category to infer something about the meaning of the word. Thus, nouns typically refer to objects, whereas verbs typically refer to actions. To test this, we used a word-learning task with 23-month-old children: they watched videos in which an object performed a simple action, and were taught either a new verb (e.g. 'Regarde, elle dase!' *Look! It's dasing!*), or a new noun (e.g. 'Regarde la dase!' *Look at the dase!*). The results showed that toddlers interpreted the new word as referring to the action only when it was presented in verb contexts (Bernal, Lidz, Millotte & Christophe 2007; see also Waxman, Lidz, Braun & Lavin 2009; Hall, Waxman, Brédart & Nicolay 2003). These results thus show that French 2-year-olds are capable of using the syntactic contexts in which unknown words occur to infer their

syntactic category as well as their possible meanings (object vs. action). Overall, this series of results is consistent with the idea that infants as young as 18 months of age may be able to use functional elements in order to identify the syntactic category of neighbouring content words.

4. Building a 'syntactic skeleton' with phrasal prosody and function words

Our working hypothesis is that children might use function words and prosodic cues simultaneously in order to create a first-pass syntactic analysis of the sentences they hear, or 'syntactic skeleton'. To test the plausibility of this hypothesis, we presented French adults with 'jabberwocky' sentences in which only phrasal prosody and function words were preserved: all content words were replaced by non-words. With these stimuli, adults are thus placed in the situation of young children who would already know the phrasal prosody and function words and morphemes of their language, but not yet all the content words. Participants had to perform an abstract word detection task in which target words were specified with their syntactic category. There were two experimental conditions: in the 'Adjacent function word' condition, the target words were immediately preceded by an informative function word (nouns were preceded by articles, verbs by pronouns); in the 'Function word and prosody' condition, target words were preceded by another content word and a more complex analysis relying on *both* prosodic information *and* function words was necessary to perform the task. Examples of the experimental sentences are given below: ('pirdale' is the target word, and a possible French translation of the jabberwocky sentences is given below each test sentence; square brackets mark phonological phrases).

"Adjacent function word" condition

Verb sentence:
[Elle **pirdale**] [tru les sbimes] [de grabifouner]
[Elle **promet**] [toutes les semaines] [de téléphoner]
*She **promises** every week to phone*

Noun sentence:
[Un **pirdale**] [ga tachin proquire]
[Un **cadeau**] [fait toujours plaisir]
*A **gift** always gives pleasure*

"Function word and prosody" condition

Verb sentence:
[Un gouminet] [**pirdale** tigou] [d'aigo soujer]
[Un étudiant] [**promet** toujours] [d'être sérieux]

Noun sentence:
[Un gouminet **pirdale**] [agoche mon atrulon]
[Un incroyable cadeau] [attire mon attention]

French adults had to detect a word specified with its syntactic category; for instance, they had to detect the verb 'pirdaler' *to pirdale*, or the noun 'le pirdale' *the pirdale*. If the target was a verb, participants had to respond if the next sentence contained that verb, but refrain from responding if the next sentence contained a noun homophonous to that verb (and vice-versa for the detection of the target noun).

The results, presented in Figure 4, show that participants were perfectly able to use the presence of a function word to infer the syntactic category of the non-word following it ('adjacent function word' condition): in 90% of cases, a non-word preceded by an article was correctly interpreted as a noun, whereas it was interpreted as a verb when preceded by a pronoun. Participants were also able to jointly use function words and prosodic cues ("function word + prosody" condition): when the phonological phrase boundary was placed before the target non-word (verb sentence), participants gave 90% verb answers, whereas they answered at random for noun sentences, in which the target word was not preceded by a phonological boundary.

In this experiment function words and phonological phrase boundaries allowed listeners to construct a skeleton of the syntactic structure of sentences, even when they didn't know the meaning of the content words. To correctly interpret sentences such as "[Un gouminet] [**pirdale…**]", participants had to use phonological phrase boundaries to establish syntactic constituents boundaries. They then used the function word "un" *a* to infer that the first constituent was a noun phrase: "$[\text{Un gouminet}]_{NP}$ [**pirdale…**]". This noun phrase in turn is likely to be followed by a verb phrase, "$[\text{Un gouminet}]_{NP}$ $[\textbf{pirdale}_{V}\textbf{…}]_{VP}$" hence the interpretation of the target non-word 'pirdale' as a verb. In the case of noun sentences, the phonological phrase boundary occurred *after* the target word. Participants thus did not have access to prosodic information when they processed the target word. A post-hoc analysis showed that responses given before the end of the target word (before having access to prosodic boundary information) were mostly verb responses (the most standard syntactic construction being article+noun+verb), and that subjects revised their interpretation upon hearing the prosodic boundary

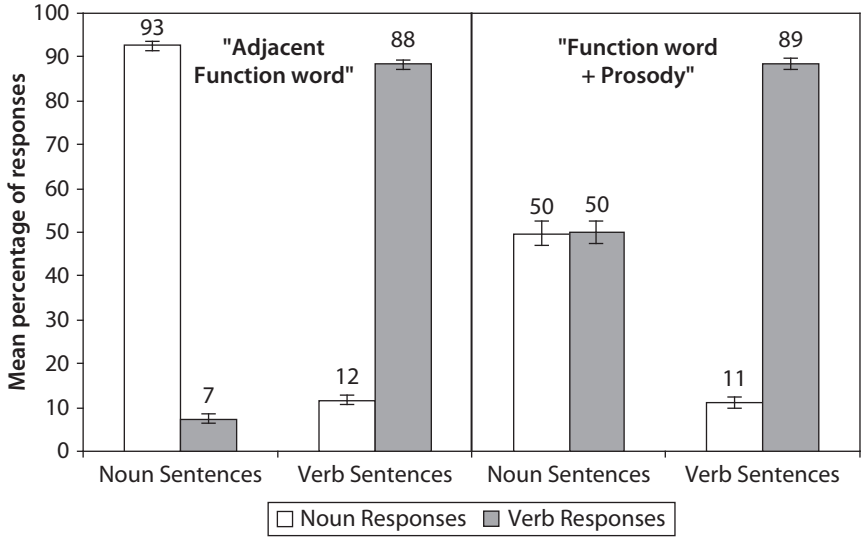


Figure 4. Results of an abstract word-detection task with jabberwocky sentences: subjects correctly identified the syntactic category of an unknown content word immediately preceded by a function word (left-hand bars). When the target word was preceded by another content non-word, subjects performed better than chance overall (adapted from Millotte, Wales, Dupoux & Christophe 2006).

placed after the target word (with a majority of noun responses for responses given after the end of the target word).

These data show that adults are able to build a syntactic skeleton even for sentences for which they do not know the content words. Therefore, 18-month-old infants, who have been shown to already know much about both the phrasal prosody of their native language, and their function words, might well be able to do the same. They would then be able to exploit this syntactic skeleton in order to facilitate their acquisition of the meaning of words, and of other aspects of the syntax of their native language.

5. Conclusion

To sum up, the data presented in this chapter, we suggested that children might start to acquire the syntax of their native language by focussing on two sources of information which can be available to them very early on, namely phrasal prosody and function words. We showed that adults are capable of exploiting the presence of phonological phrase boundaries to constrain their on-line syntactic analysis of

sentences (Millotte et al. 2007, 2008). These results support the hypothesis that listeners compute a pre-lexical representation broken up into prosodic units, and that they use such representations in their analysis of the syntax of sentences. Since infants also process phrasal prosody, and are able to exploit phonological phrases to constrain lexical access (see e.g. Gout et al. 2004), it is plausible that just like adults, they may also exploit phrasal prosody for syntactic analysis.

As regards function words, several studies have demonstrated that young children have knowledge of the function words of their mother tongue by the end of their first year (Hallé et al. 2008; Shafer et al. 1998; Shi et al. 2006), and already associate articles with nouns before the age of 18 months (Höhle et al. 2004; Shi & Melançon, in press). In addition, we showed that they also associate pronouns with verbs by the age of 18 months (Cauvet et al. 2010), and are able to exploit the syntactic context of a new word to infer its syntactic category and guess its meaning by the age of 2 years (Bernal et al. 2007).

Finally, we suggested that listeners (both adults and children) may construct a first-pass syntactic analysis, the syntactic skeleton, by relying on two sources of information simultaneously: prosodic boundaries, which coincide with syntactic boundaries, and function words that may be used to label these units. This hypothesis is supported by the results obtained in our final experiment with jabberwocky sentences (Millotte et al. 2006). Eighteen-month-olds seem to be in a situation similar to that experienced by the adult participants in our jabberwocky experiment: they have access to the function words of their mother tongue and are sensitive to phrasal prosody; they may thus be able to compute the 'syntactic skeleton'.

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CHAPTER 4

Language acquisition in developmental disorders

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In this chapter, I review recent research into language acquisition in developmental disorders, and the light that these findings shed on the nature of language acquisition in typically developing children. Disorders considered include Specific Language Impairment, autism, Down syndrome, and Williams syndrome. I argue that disorders of language should be construed in terms of differences in the constraints that shape the learning process, rather than in terms of the normal system with components missing or malfunctioning. I outline the integrative nature of this learning process and how properties such as redundancy and compensation may be key characteristics of learning systems with atypical constraints. These ideas, as well as the new methodologies now being used to study variations in pathways of language acquisition, are illustrated with case studies from Williams syndrome and Specific Language Impairment.

1. Introduction

What light can developmental disorders shed on language development? To what extent can disorders reveal the nature of the biological constraints that contribute to language development? Can they uncover the extent to which language learning relies on general cognitive mechanisms compared to domain-specific mechanisms? In this chapter, we consider what has been learned by the comparison of language development across multiple disorders, as well as the unresolved issues that still exist in the field. In this chapter, I present arguments and evidence supporting one current view of the constraints that channel language development. This account emerges from the *neuroconstructivist* theoretical framework (Karmiloff-Smith 1998; Mareschal et al. 2007; Westermann, Thomas & Karmiloff-Smith 2010). In the following account, developmental disorders are seen as arising from atypical constraints on the processing of information streams that feed

into language, plus the effects of redundancy and compensation. In the next paragraphs, we begin by clarifying what is meant by developmental disorders, and distinguishing the different explanatory frameworks used to account for behavioural deficits observed in these disorders. In Section 2, we then move on to consider language as a learning problem, and language disorders as altered versions of this learning problem.

First, let us clarify what is meant by developmental disorders. Developmental disorders can be split into four groups. The first are disorders caused by well-understood genetic abnormalities, such as Down syndrome (three copies of chromosome 21) and Williams syndrome (deletion of around 28 genes from one copy of chromosome 7; Tassabehji 2003). In these neurogenetic disorders, cognitive impairments are typically not restricted to a single cognitive domain. The second group are disorders defined on the basis of behavioural deficits, such as dyslexia, Specific Language Impairment and autism. In these disorders, behavioural genetics indicates sometimes substantial heritability, but the causal genes are not yet known and may well not be mutations (that is, they may be spectrum disorders corresponding to an unlucky accumulation of normal genetic variations that each add a small risk for the target disorder). In these disorders, it is sometimes argued that the deficits are restricted to single cognitive domains (e.g., reading in dyslexia, language in Specific Language Impairment) but there remain doubts as to whether these disorders are indeed homogeneous rather than behavioural clusters with milder associated deficits and heterogeneous causes. The third group correspond to disorders where there is learning disability but its cause is unknown. The final group correspond to disorders caused by environmental factors, such as acquired brain damage, viral infections or an impoverished environment, be it cognitive (such as neglect) or biological (such as in Foetal Alcohol syndrome). The first and last of these four groups index the primary locus of causality – the first group nature, the last group nurture – while the middle two reflect our current lack of knowledge about the cause of some disorders. Lastly, a given behavioural impairment may be generated in more than one way. For example, poor reading may be the consequence of either dyslexia or limited opportunities to learn to read. Our discussion will predominantly focus on the first two of these four groups – neurogenetic and behavioural disorders. A discussion of language development under conditions of impoverished input can be found in Goldin-Meadow (2005). Disorders of development that are caused by early acquired brain damage will be considered briefly in Section 4.

Both dissociation and association methodologies have been applied to characterise developmental disorders of language (see Bishop 1997; Karmiloff-Smith 1998; Temple 1997, for discussion). Where *ability A* develops normally but *ability B* develops atypically, a possible inference from the dissociation is that the abilities

are subserved by independent systems that do not interact during development. Where *ability A* and *ability B* both develop atypically, one possible inference from the association is that a common system subserves their development; another is that they are subserved by two systems that causally interact across development (Morton 2004). Very different explanatory frameworks have been deployed in interpreting language deficits in developmental disorders. On the one hand, some researchers have extended the logic of adult cognitive neuropsychology to developmental disorders, hypothesising that patterns of behavioural deficits should be related to normal modular theories of the language system (for the appropriate age); deficits are then viewed as the failure of individual components to develop while the rest of the system has developed normally (e.g., Clahsen & Temple 2003). On the other hand, other researchers stress the interactive, adaptive nature of the developmental process; they argue that the normal adult modular structure is the product of the developmental process rather than a precursor to it and, since cognitive components interact across development, impairments are likely to spread; moreover, genetic effects in disorders are typically widespread in the brain rather than equivalent to focal lesions; together, these researchers infer that the language system in developmental disorders may be qualitatively atypical and therefore one need expect no direct correspondence to the normal language system (e.g., the *neuroconstructivist* position; see Karmiloff-Smith 1998; Mareschal et al. 2007; Thomas & Karmiloff-Smith 2002, 2005; see Thomas, Pursuer & Richardson, in press, for a more detailed comparison of these position). Currently, then, some researchers believe that developmental disorders of language offer a direct window onto the structure of the normal language system by virtue of revealing independently developing components; meanwhile, others argue that disorders offer only indirect clues about normal language development in terms of the constraints shape it. This in fact resolves into two questions: (1) whether the language system is made up of predetermined independently functioning parts (so-called modularity theory) or whether specialised components are a product of the developmental process; and, (2) the generality or specificity of the influences of the disorder on the language acquisition process.

The following examples illustrate the types of claims that have been made about language development in development disorders. It has been argued that Specific Language Impairment may be a genetic failure of language (and in some cases, only syntax) to develop against a background of otherwise normally developing cognition (e.g., as assessed by non-verbal intelligence tests) (Pinker 1999; van der Lely 2004). Williams syndrome, a rare neurogenetic disorder, shows an uneven cognitive profile, with relatively strong language ability (for overall mental age) and especially in receptive vocabulary, combined with a particular weakness in visuospatial construction and a background of learning disability.

Based on early reports, Pinker (1994, 1999) argued that language might develop normally in this disorder despite deficits in general cognition. In high-functioning individuals with autism, it has been argued that the structural parts of language can be acquired appropriately but these individuals do not master its use in social situations, which is crucial for effective communication (Happé 1994). These three claims revolve around disorders that exhibit dissociations. Equally, we need explanations of associations, for example where all aspects of language development are delayed in a disorder but individuals nevertheless seems to follow normal milestones, though perhaps terminating at a lower level of sophistication. What property of a cognitive system could produce general language delay? Speculations about how language development can go wrong rely on a detailed understanding of how it works in the normal case.

2. Language as a learning problem

The effects of developmental damage to the language system may be quite different to the effects of acquired damage in adulthood, because in the former case one cannot assume that there is already a language system in place (Thomas & Karmiloff-Smith 2002). Instead, developmental deficits must be interpreted as disruptions to an adaptive learning process. Theories of language development differ depending on how tightly constrained they view the learning process to be: very tightly in nativist theories, where environmental input serves to 'trigger' adult states; weakly in empiricist theories where structure in input-output mappings serves to construct the adult state from more general resources. Minimally, developmental disorders must be viewed in terms of changes to the constraints under which language development takes place, whether learning is tightly or loosely constrained. But learning theories bring into play a range of other concepts. These include the interactions between different information sources or processing mechanisms, the importance of the quality of input and output representations, changes in plasticity with age, compensation between processing components when some are initially impaired, and the possibility of redundancy (i.e., multiple developmental pathways to success).

At the most abstract level, Tager-Flusberg and Sullivan (1998) characterised normal language development as involving the integration of three streams of information: about the physical world, about people, and about the structure of language itself. Ultimately, these will form the basis of lexical semantics, pragmatics, and phonology/syntax respectively. These information streams are depicted in Figure 1. The most important point is that language development involves the *integration* of these information sources – to use some linguistic

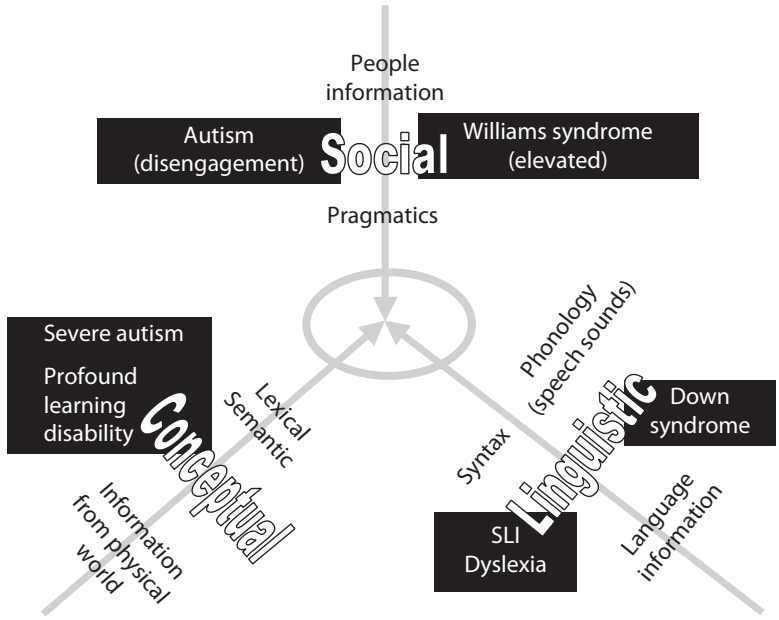


Figure 1. Information streams combined in language acquisition, along with developmental disorders in which the primary deficits relate to one of the streams.

structure to convey some meaning to achieve some social goal. But integration may be a complex process: some types of information may be redundantly available in more than one information stream; or information in one stream may help resolve ambiguities in the other and so aid its acquisition (the basis of the developmental notion of *bootstrapping*). In this way, Chiat (2001) emphasised how theories of language development must construe observed impairments in terms of the way each disorder changes the problem of learning the mapping from sound to meaning and from meaning to sound.

Cross-syndrome comparisons are potentially most informative about the different ways in which the developmental process can be deflected. Figure 2 demonstrates data from our lab that illustrate the sorts of patterns that can be observed when disorders are compared (see Annaz 2006; Thomas et al. 2009, for general methods). These data depict cross-sectional developmental trajectories for 18 children with Williams syndrome (WS), 15 children with Down syndrome (DS), 16 high-functioning children with autism (HFA), and 17 low-functioning children with autism (LFA) between the ages of 5 and 12, against a typically developing (TD) sample of 25 children. The upper panel shows performance on a standardised test of receptive vocabulary (a task where the child has to point to

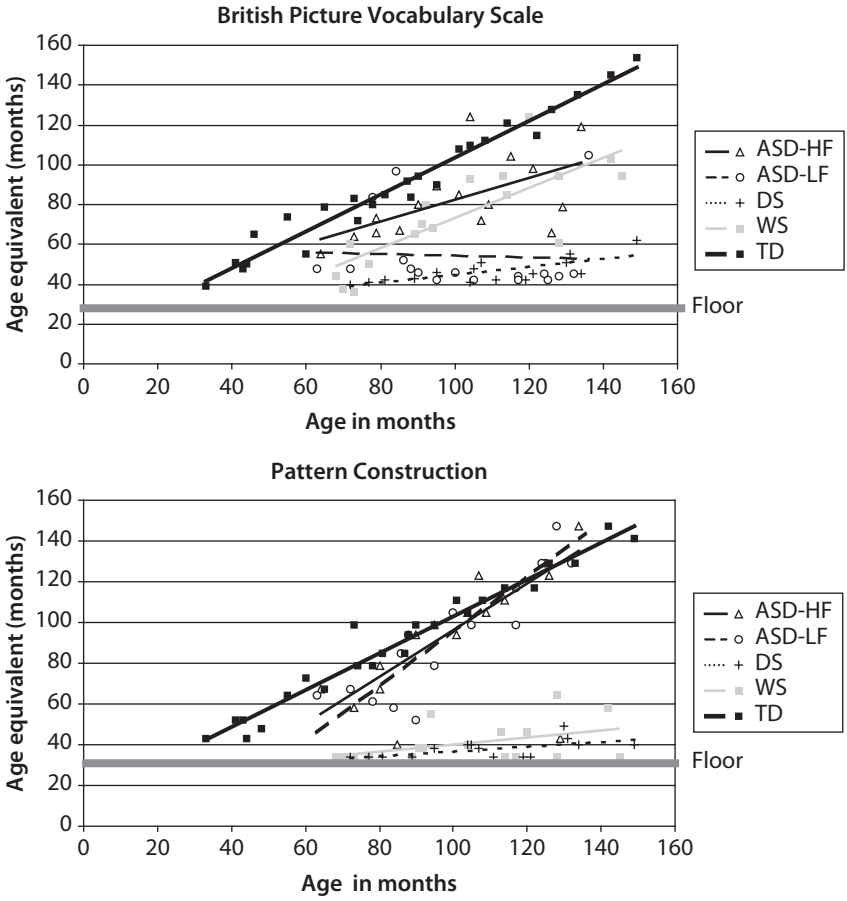


Figure 2. Cross-sectional developmental trajectories for children with different developmental disorders on two standardised tests (Annaz 2006). Upper panel: British Picture Vocabulary Scale (Dunn et al. 1997); lower panel: Pattern Construction from the British Abilities Scales (Elliott et al. 1996). ASD = Autistic spectrum disorder, HF = high functioning, LF = low functioning, DS = Down syndrome, WS = Williams syndrome, TD = typically developing controls.

the picture that goes with a word), while the lower panel shows performance on a non-verbal test of visuospatial construction (a task where the child has to complete a simple puzzle, building a target pattern from geometric shapes). In both cases, test (mental) age is plotted against chronological age.

Two of the disorders show similar profiles across verbal and non-verbal measures, illustrating *developmental associations*. For the HFA group, development is slightly below the TD trajectory but within the normal range, while the DS group

shows very delayed and only slowly improving performance on both measures. By contrast, the WS group shows development parallel to and just below the normal range for language (similar to the HFA group), but very delayed development on visuospatial construction (similar to the DS group). Meanwhile, the LFA group shows poor performance on language development (indeed, there is no significant improvement with chronological age in this cross-sectional sample) but then development within the normal range for visuospatial construction (similar to the HFA group). These latter two cases illustrate *developmental dissociations*.

Such cross-syndrome comparisons have been carried out to explore associations and dissociations within the domain of language itself, both in early development (Tager-Flusberg & Sullivan 1998) and later childhood (Fowler 1998) (see also Rice, Warren & Betz 2005). These comparisons focused on phonology, syntax, semantics and pragmatics, and identified several contrasting profiles. For high-functioning children with autism, problems primarily occur in pragmatics, in line with the social disengagement typical of the disorder. For low-functioning children with autism, there are additionally problems with lexical semantics and concept formation. Problems in lexical semantics and concepts also characterise the development of children with learning disability (or 'mental retardation', to use US terminology). In Williams syndrome, language development is mostly characterised by delay but with a relatively successful eventual outcome. However, there are also differences in pragmatics, but now the pattern is of hypersociability with an elevated interest in using language for social engagement. In Down syndrome, problems appear to primarily impact on the structural aspects of language, especially phonology and those parts of language that rely on phonological distinctions (morphology, syntax). Specific Language Impairment and dyslexia are also viewed as behavioural disorders that impact primarily on structural language information, with sub-types emphasising difficulties in phonology, semantics, or syntax. The contrast between these disorders is included in Figure 1.

What kinds of conclusions have been drawn from these comparisons? Fowler (1998) noted that pragmatics and semantics appear to be most closely tied to overall mental age across different disorders, while phonology and syntax can dissociate. Either pragmatics and semantics involve more general systems, or their successful development requires interactions between a greater number of cognitive components. McDonald (1997) contrasted various populations in which language acquisition is broadly successful (including WS and HFA) with those in which language acquisition is unsuccessful (including DS and SLI, but also late L1 and L2 learners). Her conclusion was that good representations of speech sounds (phonology) are crucial in predicting eventual successful acquisition. When the individual cannot encode the basic phonological contrasts over which the rules of language operate, prognosis is poor. However, as Morton (2004) argues, many

cognitive components typically contribute to the successful development of an overall system, and if any one of these is impaired (and no redundancy is present) the system may fail to develop normally. Good phonology may be a necessary but not sufficient requirement for successful language acquisition.

In their reviews, both Fowler (1998) and Tager-Flusberg and Sullivan (1998) were struck by the absence of radically different pathways by which language can develop. In most disorders, acquisition exhibits similarities to the normal trajectory, proceeding through a common sequence and via common milestones (as far as acquisition progresses in a given disorder). Their common conclusion was that these similarities must be the result of invariant internal biological constraints that shape language development in all the disorders. Thus Fowler argued that "…language acquisition (is) heavily constrained by brain structure" (1998: 309), while Tager-Flusberg and Sullivan concluded that "there are not multiple alternative ways of acquiring language, though as each of these components (phonology, semantics, and syntax) develops over time, they may become integrated in different ways, which lead to syndrome-specific profiles" (1998: 231). An alternative possibility is that, on computational grounds, some of the similarities to typical development are to be expected since learning systems with different properties are nevertheless trying to solve the same problem; that is, all the children are trying to solve the problem of communicating meaning via sound (Thomas 2005a; Thomas, Karaminis & Knowland 2010).

In the next two sections, we consider two more detailed examples of language acquisition in developmental disorders. These stress how important it is to view atypical language development in terms of the trajectory of an adaptive learning system operating under altered constraints (computational or informational). The first example shows how research has progressed over a decade or more of investigating language development in Williams syndrome, and introduces the idea of *redundancy* in language development. The second example of Specific Language Impairment reveals the emergence of new methods to address key issues in the atypical development of language, and introduces the idea of *compensation*.

3. The case of language development in Williams syndrome

Williams syndrome has been much studied over the last fifteen years due to the uneven cognitive profile observed in this neurogenetic disorder (Donnai & Karmiloff-Smith 2000). Figure 2 depicts one of the most salient dissociations observed in standardised testing: a disparity between receptive vocabulary and visuospatial constructive skill. Individuals with WS also show a hypersociable or 'over-friendly' personality profile (Jones et al. 2000), with a relative strength in

facial recognition (Annaz et al. 2009). By contrast, they have relative weaknesses in numeracy and problem solving skills, and overall IQs typically fall between 50 and 70. Based on the early findings of Ursula Bellugi from a small number of individuals with the disorder, Pinker (1994, 1999) argued that WS might constitute a genetic dissociation in which grammar develops normally but general intelligence is impaired – in support of a wider argument that normal language development involves innate, domain-specific mechanisms. Although, as with any disorder, there is variability, individuals with WS often have a surprising facility with language compared to some of their other abilities, and compared to other disorders with comparable overall mental age such as Down syndrome (e.g., as shown in Figure 2). A dissociation of this nature encourages the idea that developmental disorders might serve to 'fractionate' the cognitive system into its component parts. The simple fractionation proposed by Pinker (1994) is shown in Figure 3a. (To place this in some historical context, Figure 3b represents the immensely more complex picture that has emerged from subsequent research.)

These initial claims inspired a burst of research on WS that has lasted fifteen years and incorporated investigation of the genetic basis of the disorder, its effects on brain development, and a detailed consideration of the cognitive abilities of these individuals using more sensitive experimental tasks. Research on brain development has tended to indicate that the genetic effects of the mutation are fairly widespread rather than focal, consistent with most neurogenetic disorders that affect cognition (Toga, Thompson & Sowell 2006). By contrast, research on the cognitive abilities of these individuals has revealed an increasingly complex and fine-grained picture. In the domain of language, the most salient characteristic in WS is that development is delayed (Brock 2007). Early in childhood, the language ability of these children is on a par with children with DS (Paterson et al. 1999). Only in later childhood and adolescence does WS language development continue to improve while that of individuals with DS asymptotes (see Richardson & Thomas 2009, for discussion). In most published empirical studies, the performance of individuals with WS is compared to a typically developing control group matched for *mental age* (MA); performance is very rarely at the level of a control group matched for chronological age. MA comparisons implicitly accept that there is no dissociation between language ability and overall mental age in WS (although the notion of a single, overall mental age is itself undermined in disorders in which component abilities are at different levels).

Various studies of WS have reported dissociations within the domain of language, for instance problems in learning spatial prepositions, difficulties in the pragmatics of conversation, and problems with more complex aspects of morphology. Thomas and Karmiloff-Smith (2003) reviewed the literature at the turn of the century and identified two types of emerging hypothesis. The *Semantics-*

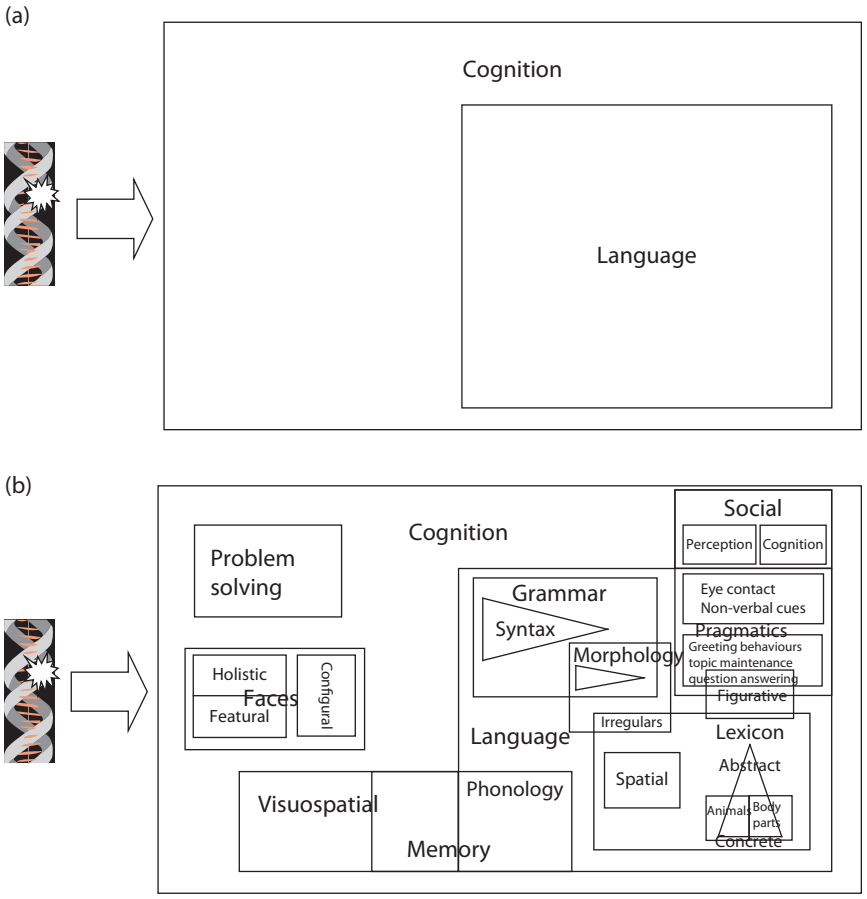


Figure 3. Developmental fractionation of cognition in Williams syndrome. (a) early characterisation: genetic mutation produces simple fractionation between general cognition and language; (b) subsequent research indicates complex pattern of fractionation in both linguistic and non-linguistic domains (Thomas 2006). Labelled boxes indicate dissociations reported by one or more studies in the literature. Triangles indicate domains in which there is a scale of difficulty, with individuals with WS reported to show exaggerated deficits on harder parts of the domain.

Phonology Imbalance hypothesis suggested that individuals with WS are relatively strong in their language development but that it occurs in a subtly atypical way. In WS, there might be greater emphasis on the sounds of words and less emphasis on their precise meaning. For example, in early language development, children with WS show vocabulary growth ahead of the normal markers of semantic development such as referential point and object sorting (Mervis & Bertrand 1997;

see Thomas 2005a, for a review). By contrast, the *Conservative hypothesis* suggests that there is nothing atypical about language development in WS – it is entirely in line with mental age (i.e., it is delayed). What anomalies there are stem from other characteristics of the disorder such as the visuospatial deficit that causes problems in learning spatial prepositions (*in*, *on*, *under*) and the hypersociable profile that leads these individuals to use language strategically in a way to capture and maintain attention in social interactions (see, e.g., Thomas et al. 2006, for an example in the context of unusual vocabulary use in WS). Under the Conservative hypothesis, language in WS is made to look more impressive by comparing it to other cognitive domains in which there are particular weaknesses (e.g., visuospatial construction) and to other disorders in which there are known phonological processing problems, such as DS and SLI (e.g., Ring & Clahsen 2005).

As research has progressed in WS, methodological problems such as restricted sample sizes and inappropriate control groups have increasingly been addressed. Brock (2007) recently reviewed the status of the two competing hypotheses. He found that the *Conservative hypothesis* has gained progressively more support over the *Imbalance hypothesis*. Delay remains the most salient feature of language development in WS and performance appears to be in line with the level of general cognition (excluding the visuospatial deficit). While there are some anomalies compared to MA-matched control groups, most of these appear to stem from other non-verbal aspects of the disorder. One exception may be receptive vocabulary (e.g., as shown by the data in Figure 2, left panel). This skill is puzzlingly strong even compared to the rest of language and the disparity remains to be explained. Brock (2007) argued that the slow and anomalous early phase of language development in WS combined with the eventual relative success in acquisition implicates *redundancy*. That is, early language development in the disorder does not exploit the normal combination of information sources and cognitive processes; it finds a pathway to success that takes longer but is nonetheless eventually successful. This position contrasts with that of Tager-Flusberg and Sullivan (1998) who, as we saw earlier, argued against alternative pathways for successful language acquisition. (See Musolino, Chunyo & Landau (2010) and Thomas, Karaminis & Knowland (2010) for a recent debate on generative versus neuroconstructivist views of language development in Williams syndrome.)

To offer a concrete example of this redundancy, Laing et al. (2002) identified deficits in shared attention in toddlers with WS. Although these toddlers scored well on dyadic interactions (sharing attention with the caregiver), they exhibited deficits in triadic interactions, where attention had to be shifted between the caregiver and an object that was being played with. The deficit was a consequence of their elevated interest in (and fixation on) the face of the caregiver. It is thought that triadic interactions are an important contributor to learning object names

in situations where the caregiver labels an object that is being played with (*"Look at the ball! This is a ball!"*) (e.g., Tomasello & Farrar 1986). Therefore, the toddler with WS may, to some extent, be deprived of this information source in their language development. However, explicit labelling is not the only route to learning object names, and while development is slower, these children do succeed in vocabulary acquisition. The inference is therefore that other redundant pathways to success are followed, which are less efficient and take longer.

Overall, research into the cognitive profile of individuals with WS has tended to produce increasingly fine-scaled fractionations between different abilities even within cognitive domains. Although the initial fractionation in WS was argued to be between language and cognition as shown in Figure 3a, the current picture of is closer to that shown in Figure 3b. The complexity of this latter figure, with its patterns of subtle dissociations, reflects the greater complexity of the WS cognitive profile that has subsequently emerged. The fine-scaled fractionation contrasts with the coarse and widespread effect of the genetic mutation on brain development. One can make this point more starkly: in WS, the granularity of genetic differences in cortex is far coarser than the level of cognitive modules, yet the impact on cognitive development is a granularity of subsequent fractionations considerably finer than the level of cognitive modules (Thomas 2006). The difference in granularity between genetic and cognitive effects arises because cognitive structure is the result of a developmental process that exaggerates or attenuates the effects of atypical constraints on learning, depending on the cognitive domain (Karmiloff-Smith 1998). In the next section, we will see how new methods are important to specifying the nature of this developmental process.

4. The case of language development in Specific Language Impairment

SLI is a behaviourally defined disorder diagnosed by a deficit in language development in the presence of apparently normal non-verbal development and the absence of any obvious neurological impairment or environmental cause. It is a heritable disorder but the precise genes involved are unknown (although some candidate genes and chromosomal regions have been proposed; see Smith 2007). SLI is sometimes conflated with the British KE family. Affected members of this family were reported to have particular problems with language and the cause was traced to a mutated gene on chromosome 7 called FOXP2 (see Marcus & Fisher 2003; Fisher 2006). As with WS and in keeping with other neurogenetic disorders, subsequent research has indicated that cognitive differences and brain differences between affected and unaffected family members are more widespread than the

domain of and substrate for language (Watkins, Dronkers & Vargha-Khadem 2002; Watkins et al. 2002). However, behaviourally defined SLI is not caused by the FOXP2 mutation (Newbury et al. 2002).

SLI is a disorder that primarily impacts on syntax and phonology, although its particular features depend on the language being acquired (Leonard 1998). It appears to be a heterogeneous disorder, with subtypes that differentially impact morphology/syntax, semantics, and pragmatics (Bishop & Norbury 2002). Three broad types of theory have been advanced for the cause of behaviourally defined SLI (see Leonard 1998; Ullman & Pierpont 2005). First, SLI has been explained in terms of deficits to rule-based, language-specific structures (e.g., van der Lely 2004). Versions of this theory include an impairment in specific structural relationships (agreement, specifier head-relations), absent linguistic features, fixation in a period of development where tense marking is 'optional', and problems in more general language functions (implicit rule learning, representing relationships between structures). Alternatively, the language-specific deficit might be lower level, involving a deficit that particularly affects phonology, and perhaps the maintenance of phonological information during on-line language processing (e.g., Joanisse 2007). Second, SLI has been explained in terms of a more general non-linguistic processing deficit that happens to particularly impact on language (Leonard 1998, for a review). Proposals on the nature of this impairment include reduced processing rate, capacity limitations on cognitive processing, and a low-level perceptual or temporal processing deficit. Third, a neurobiological proposal by Ullman and Pierpont (2005) called the *Procedural-Declarative theory* argues that grammar acquisition is like skill learning, and therefore relies on procedural or implicit memory. By contrast, vocabulary acquisition concerns the learning of explicit knowledge and therefore relies on declarative memory. SLI corresponds to a developmental impairment of the procedural system. All of these theories identify the deficits in SLI as involving disruptions to the language information stream in Figure 1.

Ullman and Pierpont's (2005) proposal is notable in that it identifies *compensation* as a key feature in producing the language profile of children with SLI. In the face of an impairment to the procedural learning system, Ullman and Pierpont argue that the declarative memory system attempts to compensate by acquiring certain aspects of language, such as frequently used phrases or inflected words. So, for example, where a typically developing child might inflect an English past tense such as 'talked' in terms of the regularities that operate in inflectional morphology (in English, to form the past tense, add -ed to the verb stem), the child with SLI might succeed in inflecting this high frequency verb by learning it as an unanalysed whole (note, however, that the performance of these children on inflection tasks is generally fairly poor). The evidence put forward

for the compensation is that where normal children inflect regular verbs equally accurately irrespective of their frequency, children with SLI show frequency effects, inflecting high frequency regulars more accurately than low frequency regulars (van der Lely & Ullman 2001). Frequency effects are taken to be the hallmark of the operation of declarative memory.

What is important about Ullman and Pierpont's approach is that it emphasises the atypical learning process. Impaired behaviour is the outcome of development working under different constraints, rather than the result of focal damage to a component of a static system. That is not to say that damage to a static system might not sometimes be an appropriate explanation, for instance, to explain a similar behavioural deficit when observed in a normal adult who has suffered brain damage. For example, individuals suffering Broca's aphasia after left anterior damage exhibit particular problems in processing grammar. However, focal damage in normal, otherwise healthy children before the age of 5–7 does not produce SLI; it causes language delay followed by recovery to within the normal range (see Bates & Roe 2001, for a review). Interestingly, the effects of early child brain damage are similar irrespective of side of damage. By contrast, in adults impairments in processing the structural aspects of language only occur after left-sided damage. In short, then, SLI must be viewed as an atypical developmental process, not in terms of damage to pre-existing structures.

However, Ullman and Pierpont's approach highlights the fact that we don't really know what the atypical developmental process looks like (Thomas 2005b). How does compensation actually work? Why is it not fully successful, in which case the atypical process would manifest no surface behavioural impairments? The implication is that compensatory processes are limited in some respect; but unless the processes are specified in detail, sufficient to make predictions about what level of compensation a given theory would suggest, proposals about compensation cannot be falsified and the attendant theories are untestable. Two recent methodologies have begun to make progress in specifying the nature of compensatory processes.

One of the methodologies is the use of computational models of development to provide formal, implemented simulations of the proposed atypical process (Thomas & Karmiloff-Smith 2003). This approach begins by building a computational model of normal development for a particular aspect of language acquisition, such as learning to produce past tenses or to parse sentences. The normal developmental trajectory is the consequence both of the linguistic environment to which the system is exposed and its internal computational constraints, such as the nature of its representations and learning algorithm. Manipulations to the linguistic environment and internal computational constraints provide candidate hypotheses to explain atypical development, if those manipulations are able to

deflect the normal trajectory so that it now characterises the pattern observed in a particular disorder.

In this way, Thomas (2005b) demonstrated how altering a computational property in a connectionist model of English past tense acquisition was sufficient to deflect development from the normal trajectory to the SLI profile. This property was the discriminability of the internal processing units (roughly corresponding to the signal-to-noise ratio of a neural processing system). This manipulation was notable for three reasons. First, the property was altered in a processing channel that was shared by both regular inflections (*talk-talked*) and irregular inflections (*drink-drank*), yet it affected regular inflections more seriously than irregulars. This is because good discriminability is necessary to learn the sharp category boundaries in internal representations that will depict rules or regularities. Changes to shared resources can therefore produce uneven deficits to the separate processes that use those resources. Second, changing the processing property at the start of development altered the way the system exploited the information available to it. In the normal system, phonological input was preferentially used to drive regular past tense formation while lexical-semantic (word-specific) information was preferentially utilised to drive irregular past tense formation. In the inefficient, slowly developing atypical system, there was a greater reliance on word-specific lexical-semantic information to drive *all* past tense formation. This led to the emergence of frequency effects in regular past tense formation observed empirically by van der Lely and Ullman (2001); and it is in line with the proposal that all verbs are treated as exceptions in SLI. Third, the model captured SLI accuracy levels in children of around ten years of age. However, the atypical model was then run on to predict adult performance. The results suggested resolution of difficulties on highly practised items, but residual difficulties when the system came to extend its knowledge to novel cases (i.e., applying the rule). In other words, externally, the system eventually seemed to compensate for highly practised items but internally it failed to normalise.

Using a similar approach, Thomas and Redington (2004) constructed a recurrent connectionist model of sentence processing to simulate the results of an experiment in which participants had to identify the agent and patient of a sentence (Dick et al. 2001). In this task, participants heard sentences that were either canonical (active: *The dog chases the cat*; subject cleft: *It is the dog that chases the cat*) or non-canonical (passive: *The cat is chased by the dog*; object cleft: *It is the cat that the dog chases*) and were required to make a binary choice as quickly as possible on which of two pictures (*dog*, *cat*) corresponded to the agent (*dog*). Dick et al. (2001) found that adults with acquired aphasia exhibited marked difficulties at identifying the agents of non-canonical sentences, that is, both passives and object clefts. When the trained 'adult' connectionist model was lesioned, it too

exhibited this pattern of deficits. However, when the same model had its processing resources reduced prior to training to simulate a developmental disorder, it generated a novel prediction that the deficits should be more marked for object cleft sentences than passives.

Let us consider why this should be the case. In the aphasic model, both passive and object cleft failed together because they were low frequency constructions, and therefore less robustly represented in the network. In the atypical model, the resource limitation reduced the ability of the connectionist network to learn information across sequences of words. Object cleft sentences are identified by a noun-noun sequence (*cat* that the *dog*) and so suffered from developmental limitations in sequence processing. However, passive sentences are also (redundantly) identified by lexical cues (past participle *chased* and preposition *by*); across development, the network learned to use these cues to identify this construction, even when its sequence processing abilities were poor. Importantly, when Dick et al. (2004) subsequently extended their paradigm to typically developing children and children with SLI, the results supported the prediction of the model: performance on passives and object clefts was closely related in adult aphasics, while in children with SLI, passive constructions were identified more accurately than object clefts.

These models demonstrate the benefit of implementation for making theories more explicit. Together, the models demonstrate: (1) how adaptive learning systems do the best they can with atypical properties they possess; (2) that compensated systems may use information sources in different ways; and (3) that atypical processing properties may allow compensation during acquisition for some parts of language but not others.

A second methodology essential to uncover the nature of compensation in developmental disorders is that of functional brain imaging. The computational simulations suggest that, with age and practise, behavioural problems can resolve even though the underlying processes have not normalised. If so, behavioural measures, especially those with poor sensitivity such as standardised tests, may be insufficient to assess developmental outcome. By contrast, functional brain imaging offers a window on the way in which the brain has adapted to perform language tasks when its computational constraints are atypical.

Using this approach, we recently imaged the brain of a 42-year-old man called CK who was diagnosed with SLI aged 6 (Richardson et al. 2006). Donlan et al. (2010, under review) compared the language profile of CK available from standardised tests and educational records when he joined a special school for children with language impairments in 1971, with his performance as an adult in order to explore the eventual outcome of language development. CK's school

records indicated a verbal IQ of 69 at 6 years of age, and particular difficulties with auditory memory and morphological inflections. The records note that CK had reduced babbling as a baby, that he used only 3 words at two years of age (girl, pig, stop) and there was then no further productive output until 5 years and 3 months (he started receiving speech and language therapy at 4 years and 11 months). CK's adult profile indicated that some aspects of his language were now within or above the normal range: receptive vocabulary was in the 99th percentile, auditory discrimination was at ceiling, picture comprehension was in the 63rd percentile, and naming showed a z-score of 0.16, i.e., slightly above average. However, CK revealed persisting deficits in tasks requiring phonological working memory: nonword repetition had a z-score of –1.94, well below the normal range, and recall of sentences was in the 1st percentile.

Functional imaging was used to explore brain activations in CK during passive listening to sentences, or reading of sentences presented one word at a time at the same rate, against a baseline of backwards speech or nonsense visual symbols. CK's performance was compared to a group of 14 adult controls. The results revealed that for CK, there was reduced activation in temporal regions normally associated with phonological processing, but *increased* activation in dorsal premotor and superior temporal regions, as well as in the caudate nucleus. The latter are all motor areas but importantly, the task that CK was asked to perform included no motor component. One must interpret results of this form with care, since there are at least three ways one could explain the differences between CK and controls: (1) as adaptive compensation; (2) as a failure of the system to inhibit task-irrelevant circuits; (3) as a case of task-irrelevant activations themselves causing functional interference (though those activations might be adaptive for some other task). Nevertheless, one possible interpretation of the findings is that CK was using additional sub-articulation during comprehension as a compensatory process to support semantic retrieval during language comprehension. Interestingly, Vargha-Khadem et al. (1998) also reported increased activation in the caudate nucleus in language tasks in the affected members of the KE family. However, those individuals also showed increased activation in Broca's area, a pattern not observed in CK.

In sum, current research of developmental disorders of language is exploiting multiple, interdisciplinary methods, including genetic, computational, and brain imaging approaches in an attempt to better characterise the nature of the atypical developmental process (see Mareschal et al. 2007, for a review of a similar multidisciplinary approach to developmental dyslexia).

5. Conclusion

Developmental disorders of language can exhibit contrasting profiles of strength and weakness. These can be traced to different information streams involved in the task of language learning. The relation of atypical language systems (such as those observed in Williams syndrome and Specific Language Impairment) to the normally developing system remains controversial, but perhaps the best approach is to view them as shedding light on the constraints that shape the learning process rather than in terms of circumscribed failures to components of the normal language or cognitive system. The recent approaches outlined here stress the importance of viewing atypical language development in terms of the trajectory of an adaptive learning system operating under altered constraints (computational or informational). This has two implications. First, it requires that researchers collect data from longitudinal or cross-sectional studies that trace the trajectories of language skills across development in different disorders. Second, the onus moves onto specifying the detailed nature of the atypical learning process, which will incorporate ideas such as redundancy (illustrated in the example of WS) and compensation (illustrated in the example of SLI). New methodologies such as computational modelling and functional brain imaging will be important complements to behavioural studies in this endeavour.

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PART II

First language acquisition

Universals and diversity

CHAPTER 5

Language development in a cross-linguistic context

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Children's language development has only been studied for a very small fraction of the world's languages. This chapter provides a brief introduction to existing cross-linguistic research on morphological and syntactic development in young children learning oral languages. The final section addresses the important issue of differences in the communicative environments of children learning to talk and the possible implications of these differences.

1. Introduction

There are about 7000 languages spoken in the world and roughly 3–400 language families. Any typically developing child can learn any language and a complete theory of how language acquisition occurs requires that we address the full range of major typological characteristics presented by the world's languages. However, at present, only 1% of the languages and 7% of the language families have even one acquisition study and these studies are largely concentrated on a small subset of Indo-European languages together with some of the languages of East Asia (Chinese, Korean and Japanese) (Lieven & Stoll 2009). Studies on the Mayan languages (e.g. Pye, Pfeiler et al. 2007), on Bantu languages (e.g. Demuth 2003; Demuth & Ellis 2009) and on Chintang, a Tibeto-Burman language of Eastern Nepal (Stoll, Bickel et al. submitted) are notable exceptions.

In this brief chapter, I focus on morphological and syntactic development. I first attend to the question of what it is that children have to be able to learn by reviewing some major typological characteristics of languages. The following sections deal with how research studies have addressed the question of how some of these features are learned either by comparing their acquisition within a language or across languages. Finally, I address the question of differences between

language learning environments and the theoretical and methodological issues that these raise. Two important preliminary points should be made. First, while I do not deal with the acquisition of sign languages, all the evidence suggests that children growing up in a native sign-language environment learn their language on the same developmental timetable as children immersed in a spoken language environment (Anderson & Reilly 2002). Secondly, this chapter is an introduction to research based on monolingual development but it is worth noting that many, if not most, children in fact grow up learning more than one language to a greater or lesser degree of competence. However the variations in the types of multilingual environments to which children are exposed and the differences in the ways that children deal with this make this a major topic in its own right that I cannot address here.

The typological characteristics of the language children are learning will be important in how they start to assemble a vocabulary and to break into structure. In their path-breaking studies, Slobin (1973) and Peters (1983) highlighted the importance of the prosodic patterns of the languages, the location of morphemes and their regularity as major factors in how easily children can identify words and inflections in what they are hearing. Languages vary greatly on these dimensions as well as many others. For example there is variation in the extent to which word order marks syntactic (English) or pragmatic (Turkish) distinctions; tone is used syntactically in some languages (the Bantu languages), lexically in others (Chinese) and pragmatically in others (English). The major arguments of the verb can be marked with word order alone (English except for pronouns), with case-marking on noun phrases (the Slavic languages) and/or with agreement markers on the verb (Quiche Mayan). There are languages with very little inflectional morphology (Chinese) and languages with extensive morphology of varying types (e.g. Finnish, agglutinating, Inuktitut, polysynthetic).

This task of comparing acquisition across different languages was originally set in motion by Slobin with the Berkeley Crosslinguistic project (Slobin & Bever 1982) which culminated in his 5-volume study of first language acquisition in 23 languages (Slobin 1985a, 1985b, 1992, 1997a, 1997b). Slobin derived and refined a set of heuristics that he called 'operating principles' which, he suggested, determined the order in which language learning occurred and the ease with which different features of a language were learned. Thus he argued that agglutinating morphology such as that of Turkish, in which there is a one-to-one mapping between form and meaning, should be easier to learn than synthetic morphology in which 'portemanteau' morphemes conflate meanings (e.g. person and tense in Slavic languages). Children learning languages in which word order is relatively unambiguously tied to major syntactic distinctions (as in English) should use

word order as a guide to syntax more reliably than children learning languages that have more flexible word order (e.g. Russian or Italian).

It is important to note that by the time children come to start producing speech, they have spent nearly a whole year (more if foetal development is included) in listening to the sounds of their language. From early on they can distinguish their ambient language from other language (Mehler, Jusczyk et al. 1988) and, over the first year, they gradually come to identify its major prosodic and phonological features (Jusczyk 1997). By the time children are 18 months old, Santelmann and Jusczyk (1998) have shown that they have learned enough about the distributional regularities of English to be able to discriminate between a legitimate string ('the car is running') and an illegitimate one 'the car can running'. In production, although the articulators restrict infants' ability to match the sounds of the ambient language, babbling also already shows increasingly language-specific features (Vihman & Croft 2007). Finally, the major socio-cognitive developments in intention-reading and communicative interaction that appear to take place universally in the last trimester of the first year allow the child to begin the process of mapping sound to meaning (Tomasello, Carpenter et al. 2005). The interaction between distributional learning, intention-reading and the typological characteristics of the ambient language sets the child out on a language-specific learning path.

One solution to the problem of how a child can learn any language of the world is to posit an innately specified Universal Grammar that, in combination with the language the child is hearing, gives rise to the underlying syntactic form of that language. All researchers agree, of course, that children must learn the actual phonetic, phonological, morphological and lexical forms, as well as the numerous particularities and exceptions in the ways that constructions work, from what they hear. The Universal Grammar proposal comes down, therefore, to a pre-given set of constraints on how sentences can be constructed and, in some versions, of parameters that, once set, will guide the child in working out more specific aspects of the language in question (e.g. the 'prodrop' parameter, which determines whether argument omission is allowed and the 'head direction' parameter, which determines dominant order between and within constituents).

Alternative emergentist (Elman, Bates et al. 1996) and usage-based theories (Tomasello 2003) suggest that the grammar of a language is constructed by the child in acquisition, starting with more local, item-based language and building up through processes of entrenchment and generalisation to more complex and abstract representations. In practice it can be difficult to distinguish these accounts since UG researchers increasingly provide a role for frequency and learning in their theories and the notion of partial generalisations on the route to a more abstract grammar is central to UG accounts. However, in principle, a rapid

grasp of abstract rules should be central to the UG account while partial productivity, piecemeal learning and lexical specificity in the early stages characterise emergentist accounts (MacWhinney 2004; Lieven 2005).

2. Morphological development

Most research on English-speaking children's learning of morphology has focussed on the long-standing battle between rule-based and schema-based accounts of past tense and plural marking (e.g. Marcus, Pinker et al. 1992; Marchman, Plunkett et al. 1997). However this debate does not transfer easily to languages with more complex morphology and no sharp distinction between "regular" and "irregular". Naturalistic studies in this tradition concentrate on the overgeneralisation rate as a measure of productivity of a morphological pattern (typically the "regular" part of the system), but in more complex systems children might be overgeneralizing more than one competing pattern simultaneously and/or the overgeneralisation rates might be extremely low (Smoczyńska 1985; Dąbrowska 2001; Krajewski, Theakston et al. submitted). Also, generalisation errors can be hard to find, depending on the sampling density (Tomasello & Stahl 2004; Rowland & Fletcher 2006). Therefore researchers may need to rely on other productivity measures, for instance, contrastive use (i.e., whether particular inflections tend to occur with limited and mutually exclusive sets of stems). A drawback of this measure (unlike overgeneralisation rates) is that we cannot be certain that the child has not just rote-learned the word and morpheme as a whole. A solution is to compare children's contrastive use to that of adults but it is important here to control for all the possibly confounding factors, like the more limited lexicon and morphological inventory of the child, as well as shorter MLU and smaller number of utterances in general. When Aguado-Orea (2004) did this for two Spanish-learning children, comparing the same verb stems and the same inflections for child and adult, he found that adults were more productive in their ability to combine these verbs and inflections than were their children and that the child's productivity increased significantly between the two halves of the study (a period of 7 months starting at 22 months). Similar results for nominal case-marking were found for one Polish-learning child (Krajewski, Theakston et al. in press). The latter study also showed the child's limited productivity in terms of contexts in which inflections were used.

Another problem of the predominant focus on English morphology is the issue of extending the models/theories to other systems. For instance it is not easy to see how a rule-based approach (even with a set of complex rules) could encompass morphological systems in which there are no obvious default endings and in

which some morphological categories may not be explicitly definable. A family-resemblance, schema-based network would seem to be a more fruitful theoretical framework. However, working out the precise shape of these schemas and the basis on which children develop them is an extremely complex task. There is, on the one hand, considerable evidence that children's morphological development is driven by the relative type and token frequencies in the input language both of the morphological forms and roots/stems that they 'attach' to (German, Köpcke 1998; Polish, Dąbrowska & Szczerbiński 2006; Spanish, Aguado-Orea 2004; English, Maslen, Theakston et al. 2004; Hebrew, Laaha, Ravid et al. 2006). On the other hand, frequency by no means always accounts for patterns of development and neighbourhood effects in terms of semantic and phonological similarity are also important. Ševa, Kempe et al. (2007) showed similar effects of Russian and Serbian diminutives on morphological learning despite very different frequencies of their use in the two languages. Krajewski, Theakston et al. (in press) showed that switching between inflectional forms of nouns depends on how similar those forms are to each other, to other competing forms, and to the rest of the system, rather than on their relative frequencies. They showed that production of a given inflection depends on what other inflection serves as a base of the switch, but also that the same base may have a different effect depending on the inflection being elicited. This effect is not readily visible in English elicitation studies, where the base is invariably the morphologically simple form. Moreover, factors such as the position of the morpheme in the word and the stress patterns of the language seem to play a role as well (Slobin 1985; Peters & Menn 1993).

Children do show early sensitivity to the morphological typology of their language: for example the binyan system of infixed vowels in Hebrew (Berman 1985), the markers of Tzeltal verbs (Brown 1998) and nominal case-markers in Polish (Dąbrowska 2001). But this is emphatically not the same as starting out with a full grasp of the underlying system. Despite this typological sensitivity, children show limited productivity, greater for some parts of the system than others, and both in terms of stems they combine with inflections, and contexts in which they use those inflections (Köpcke 1998; Dressler et al. 2003; Dąbrowska 2001; Aguado-Orea 2004; Maslen, Theakston et al. 2004; Laaha, Ravid et al. 2006; Krajewski, Theakston et al. in press, submitted). Moreover, the extent to which children's knowledge of grammatical categories marked by inflections is integrated into a broader language system seems limited as well. Dittmar et al. (2008a) showed that German children even at the age of four rely more on word order than on case (marked on the form of a determiner) when interpreting transitive sentences. In a similar, not yet submitted, study, we have shown that the reliance on word order might last at least as long in Polish, even though the case is marked directly on nouns with inflectional endings.

3. Learning argument structure

One of the most fundamental things that children have to learn about their language is how to express who did what to whom, the argument structure of verbs. Different languages do this by one or a combination of the following: case-marking on subject and object noun phrases (e.g. Slavic languages); subject (and sometimes object) agreement marking on the verb (e.g. Hungarian); and the ordering of subject and object in relation to the verb (e.g. English and French). Important studies have been concerned with when children learn these features, which ones they learn first in a language that has more than one, how the relative importance of these features in learning is ranked across languages and the role of input frequency in development. For instance, while production of passives is quite late in English, probably because full passives are rare in the input, they are early in Sesotho where they are much more frequent (Demuth 1990; Demuth, Moloi et al. 2010).

Two important programmes of research set the stage for investigating these issues. The first arose out of the Slobin cross-linguistic project mentioned above and investigated the relative importance of word order and inflectional marking in Turkish, Serbo-Croatian, Italian and English sentences, using grammatical and ungrammatical sentences in these languages in a series of act-out comprehension tasks (Slobin & Bever 1982). The second was a series of experiments conducted by Bates and MacWhinney (Bates, MacWhinney et al. 1984) in which they looked at children's ability to identify the agent of an action as a function of one or more cues, which, in some languages, could be in competition with each other: word order, case, agreement, animacy and stress. Both sets of experiments indicated early sensitivity by children to the cues of the language they were learning, that is children did not rely on the same cue or ranking of cues across all the languages. On the other hand, children did not always behave exactly like the adults who spoke their languages. Bates and MacWhinney developed a model to account for the results in different languages based on the measurement of a cue's availability (how often it was present when the child understands that the speaker is trying to express a particular function) and reliability (how often, when present, it signalled that function). The model thus allowed for cues to either reinforce each other or to be in competition. A number of studies have followed up this research (Kail 1989; Kempe & MacWhinney 1998).

One problem with these studies is that they use verbs which are familiar to the children being tested. This is in an understandable attempt to make the experiments 'child-friendly' but the problem is that children might know a lot about the argument structure of verbs with which they are familiar, without having a representation that is abstract enough for them to be able to produce an

utterance with a novel verb, for instance, in a transitive construction. The fact that in a number of languages children under 5 years of age favour animacy cues over case or word order cues is indicative of this. It is therefore very important to conduct these sorts of experiments using novel verbs or verbs that are of very low frequency. In fact, children's ability to use a particular cue (animacy, case or word order) is closely related to particular characteristics of the input such as argument drop in Cantonese or the interaction between case-marking on particular items (e.g. pronouns) and frequency in German (Dittmar, Abbot-Smith et al. 2008a; Chan, Lieven et al. 2009). Preferential looking studies further suggest that, under some experimental conditions, children may be able to discriminate the difference between argument structures with novel verbs many months before they are able to perform successfully either in comprehension or production tasks (Gertner, Fisher et al. 2006). An important focus for future research is to understand the basis of these discriminations in terms of the representations children have available and how these relate to the representations required to solve the comprehension and production tasks at a later age (Tomasello & Abbot-Smith 2002; Dittmar, Abbot-Smith et al. 2008b).

A series of other experiments suggest that children's knowledge of argument structure may vary as a function of their familiarity with the verb being used. Akhtar (1999) used what she called a 'weird word order' methodology in which children were presented with pairings between an agent-action-patient event and an utterance in non-canonical word order (e.g. *Elmo the cow meeked* for *Elmo meeked the cow*). They were then asked to say what was happening. Children aged 4;4 transformed sentences with both familiar and unfamiliar verbs into canonical English word order but the groups aged 2;8 and 3;6 were only able to manage this successfully for the sentences with familiar verbs. We replicated this result with younger children (mean ages 2;2 and 2;6) using intransitive sentences with novel verbs (Abbot-Smith, Lieven et al. 2001) and using low frequency verbs in English and French (Matthews, Lieven et al. 2005; Matthews, Lieven et al. 2007). Interestingly French children were more likely than the English children to omit the object of the verb in partially correct utterances (relying on SV, while the English children frequently used VO), a finding that we suggested might result from the variation in word order for lexical objects (*Marie pousse Jean*) and pronominal objects (*Marie le pousse*). If our explanation is correct, it shows an interesting effect of varying constituent orders on the abstraction of the transitive construction.

4. Crosslinguistic modelling

One potentially useful method for making comparisons between language development crosslinguistically is the use of computational modelling. In the main, computational work has tended to be confined to one language, usually English, and computational analyses of the input are more prevalent than attempts to model learning, particularly if this involves learning from real corpora of child directed speech (though see, for instance, Chang, Dell et al. 2006; Borensztajn, Zuidema et al. 2009). A good example of crosslinguistic computational analysis of the input is Monaghan, Christiansen et al. (2007). Input data from Dutch, French, English and Japanese were coded for the phonology and lexical category of each word. The authors analysed the extent to which phonological and distributional cues could discriminate between open and closed class words and between nouns and verbs across the languages. While there was little overlap between the languages in the phonological cues that discriminated these categories (except for length in phonemes which was significantly greater for open than for closed class words), there were interesting language differences which are of potential relevance to learning: for instance, nouns had more syllables than verbs in English while in Japanese there were more phonemes in verbs and more consonants in nouns.

Chang, Lieven et al. (2008) used a sentence prediction accuracy measure to evaluate a number of computational learning models presented with child directed speech (CDS) from 12 languages on the CHILDES database (MacWhinney 2000: Cantonese, Croatian, English, Estonian, French, German, Hebrew, Hungarian, Japanese, Sesotho, Tamil, Welsh). The models differed in the distributional statistics that they extracted from the input CDS: bigrams or trigrams of words or some combination plus the 'dual path model' developed by Chang (2002). They were then presented with test sentences which were the children's utterances in which the words in the utterance had been randomised into a 'bag of words'. The accuracy with which each successive word in the child's utterance was correctly predicted was measured. The 'dual path model' did best because it combined both linear distributional information (called 'adjacency') with a measure called 'prominence' that reflected some aspects of the hierarchical nature of language structure. This learner was the most accurate but interestingly the two measures seemed to have some typologically-specific bias in that the 'prominence measure' was more important for more analytic languages (e.g. English and Japanese) than for more synthetic languages (e.g. Croatian and Hungarian).

A last example of modelling comes from the study of optional infinitives by Freudenthal, Pine et al. (2007). Children learning English, Dutch and German go through a relatively long period in which they use non-finite verb forms where

finite forms are obligatory (e.g. *That go there* for *That goes there*, *Er laufen* for *Er läuft*).

From the point of view of a theory which maintains that children know about tense and agreement as part of their UG endowment, the prolonged period in which children do not appear to register the obligatory nature of finiteness marking is a problem. The most extensive attempt to account for this and for the cross-linguistic differences comes from Wexler's proposal that children go through an 'optional infinitive' (OI) stage in which children learning some languages do not register the obligatory nature of finiteness marking because of a 'unique checking constraint', which results in an under-specification of tense and/or agreement (the 'Agreement-Tense Omission Model', ATOM, Schuetze and Wexler 1996; Wexler 1998). The explanation of crosslinguistic differences between the high rate of OIs in West Germanic languages and its relative absence in other languages is that 'prodrop' languages (i.e. INFL-licensed, null subject languages such as Italian and Spanish), do not require agreement to be checked because the subject is represented in the inflected verb form itself. This then allows for tense to be checked and results in correct tense marking. While this theory provides a relatively good description of the phenomena, it does so at the cost of postulating an innate knowledge of tense and agreement on the one hand, and a failure to give any account of the processes by which the unique checking constraint weakens and finally disappears.

An alternative account is provided by researchers who suggest that it is typological features of the input which determine the degree of non-finiteness marking in children's learning of different languages. Wijnen, Kempen et al. (2001) point out for Dutch that in complex verbs, the auxiliary goes in the verb-second position and the participle or infinitive goes at the end of the sentence. They suggest that this may be one important factor in children learning non-finite forms separately from the finite forms (auxiliaries) that belong with them. This seems to be elegantly supported by the computational analyses of English, Dutch, German and Spanish conducted by (Freudenthal, Pine et al. 2007). A computational learner was used to process corpora of Child Directed Speech in these languages. The crucial feature of this learner was that it started from the end of utterances and worked backwards through the sentence registering sequences of words and generating novel links between words as a function of these sequences. No adjustments were made to the model for the different languages being processed. The output files that most closely matched the MLU of the child were selected for analysis and compared with the child data for the proportion of simple finite verbs, complex finites and non-finites. This procedure was successful in modelling the relative proportions of non-finite child utterances in English, Dutch and German and the very low rate of non-finite forms in child Spanish. Thus the

same procedure produced different outcomes as a function of which language was the input to the model. It also modelled development (i.e. the gradual reduction of non-finite forms) which is a direct result of learning longer and longer sequences until the finite auxiliary at the beginning of the utterance starts to be incorporated. Of course, this is an extremely simple model and, at best, it will only capture a small proportion of the factors that go into explaining children's development of finiteness marking. In particular, it cannot address the question of whether the child's system eventually develops 'rules'. For instance, Jordens (1990, 2002) suggests that auxiliaries become grammatically integrated in a sudden reorganisation in the sense that the child now has a grammatical 'rule' in place for obligatory finiteness marking. However the computational demonstration that, with exactly the same model, differences in rates of OI errors can be accounted for by the gradual learning of strings of increasing length from the input fits well with other research suggesting that, for English, the patterns of acquisition and of error in auxiliary learning, wh-inversion and other areas of syntax can also be accounted for by the learning of lexically-specific strings from the input (Theakston, Lieven et al. 2005; Rowland 2007; Lieven 2008; Ambridge, Rowland et al. 2008; Kirjavainen, Theakston et al. 2009).

There are, of course, limitations on the usefulness of computational modelling. As is frequently pointed out, many of the decisions about the form in which the data is inputted to the model and the way in which the model is tested inevitably affect the results and are likely to be distant from the reality of language processing in the child. In particular most computational approaches to language learning have not solved the problem of incorporating meaning – probably the single most important characteristic of language from the child's point of view (Chang's 2002 model is an exception since thematic roles are incorporated). However computational modelling can make an important contribution to crosslinguistic research. Using the same model across languages firstly can reveal the relative distributional 'strength' of features of the input. Secondly, it can assist in more precise formulation of the different processes involved in language learning.

5. The significance of cross-cultural differences in language learning environments

We have no idea how much input speech an infant has to hear to be able to make the kinds of discriminations made by the infants in the studies briefly outlined above. From a usage-based perspective, the amount and type of input is clearly important for the rate of development and its particular characteristics. This account depends on a progressive, meaning-based analysis of the input and

requires that children the world over register enough language for them to be able to create an increasing inventory of constructions and of relationships between them. Although, of course, nativist-linguistic theories accept that the particularities of phonology, morphology and syntax (to say nothing of discourse and pragmatics) have to be learned by children, they propose a central role for innate 'knowledge' in the learning of syntax. Thus parameter-setting accounts suggest that the child only needs to hear a small number of sentences to set the innately specified parameters (e.g. prodrop and head direction, Hyams 1994 but see Meisel 1995).

There is plenty of evidence for correlations between the amount of child directed speech and rate of language development (Barnes, Gutfreund et al. 1983). There are also relationships between various characteristics of child directed speech (CDS) and particular aspects of the children's language, for instance the proportion of fronted auxiliaries in English and children's development of auxiliary syntax (Newport, Gleitman et al. 1977; see also Pine 1994; Richards 1994); the use of nouns in CDS and the relative proportions of nouns in children's early lexicons (Pine 1992); and the proportion of syntactically-complex utterances in CDS and children's own use of complex syntax (Huttenlocher, Vasilyeva et al. 2002). And, despite the typological differences between English, German and Russian, there is a high degree of repetitiveness in the first one to three words of mothers' utterances to their children in all three languages (Stoll, Abbot-Smith et al. 2009). However if the input is so important, we have to take seriously differences in the environments in which children learn languages.

There are reports of cultures in which adults hardly talk to children at all or where they do so in ways that have been thought to be detrimental to language development, for instance, using a highly directive, imperative style. To give just a few examples: Ratner and Pye (1984) reported that Quiche Mayan mothers whisper to their babies rather than using the prosodically exaggerated speech that mothers in a number of other cultures use (Fernald, Taeschner et al. 1989). Schieffelin (1985) reported that Kaluli adults discourage babbling and baby talk and that they see themselves as 'training' their children to talk by telling them what to say. Heath (1983) in her study of the Piedmont Carolinas reports that adults think that children cannot be taught but have to learn for themselves – thus the children are not spoken to much until they themselves try to take the floor and break into language. As a final example, Ochs (1982) argues that the highly child contingent CDS that has been correlated with language advance in a number of studies is incompatible with the status hierarchies of Samoan culture and that parents are more likely to either use directives to their children or to instruct older children to interact with younger ones. In many of these cultures, infants

spend more time with groups of people rather than alone with one adult and they are often cared for by older children rather than adults.

A major problem with assessing the significance of these studies is that they are descriptive rather than quantitative. This is entirely understandable since they were conducted using ethnographic, rather than psycholinguistic, methods. In cultures that are very different to those of the industrialised cultures in which most of this research has been conducted, it is still a really difficult enterprise to collect enough data to make quantitative measurements of different characteristics of the input. A detailed appraisal of the full range of quantitative and qualitative characteristics of input from which children learn language awaits a great deal more research. However it is possible to make a number of interim observations (Lieven 1994).

First, the differences may not be as radical as they seem. Ethnographic researchers may not have access to all the environments in which children are spoken to (any more than do psychologists operating in technological cultures). For instance De León (1998) argues that children learning Tzotzil do hear CDS but usually from the grandmothers who often look after them during the day and inside the house where researchers do not go. Second, in these more rural cultures, children may learn language on a somewhat slower timetable as a result of somewhat less input. It may, in fact, be that the kinds of children usually studied by psychologists are 'precociously forward' by comparison to most typically developing children even in broadly similar cultures.

Most importantly, since all children must learn from the form-meaning mappings available to them from their environment, we need to work out how these are provided and what the child brings to the task. Small children only afford a limited number of ways of interacting with them the world over and these interactions are likely to be highly repetitive with predictable language associated with them. Babies need to be soothed, distracted and occupied. To do this requires monitoring of the infant's attention and reacting appropriately. This is likely to involve some language and to provide the child with the beginnings of a form-meaning mapping. An example comes from Schieffelin's (1985) report of the 'elema' strategy used by Kaluli adults in teaching their infants to talk. These utterances usually follow the interest or reaction of the child, for instance if another child has stolen a piece of food. They thus pair an utterance with an event structure. A second example comes from the greater use of directives that is reported for a number of these cultures. Here, too, a directive is often likely to relate to what the infant is doing (or not doing) and the idea that they are therefore non-contingent may well not be accurate. There are, in fact, studies indicating that, in the early stages of language development, directives can be helpful since they provide a clear attentional focus paired with relatively predictable language (Barnes, Gutfreund et

al. 1983). We would need a much clearer idea of how directives operate in relation to the children's level of language development in these cultures before concluding that children cannot learn from them, at least in the early stage of language development.

Finally, we have little idea how easy it is for children to extract form-meaning mappings from observing interaction. We know that children can already abstract 'event schemas' by 11–12 months (Baldwin, Baird et al. 2001) and there are a few studies showing that children can utilise overheard talk (Oshima-Takane 1988; Akhtar, Jipson et al. 2001; Akhtar 2005) but beyond this there is almost no research. The bottom line is that children must learn the particularities of their language from what they hear but more research is needed to assess just how much language they need to hear, directed to the child or not, and how form-meaning mappings are abstracted from the input in different communicative situations.

6. Conclusions

It is clear that, even after 25 years of research, there is a great deal more to be done in the field of cross-linguistic language acquisition. First and foremost, we need to study a much wider range of languages and typologies. We also need to compare languages that are close together typologically. Often what seem like small differences between languages can be highly illuminating (Strömqvist, Ragnarsdöttir et al. 1995; Pye, Pfeiler et al. 2007). All of the types of studies that I have referred to: the development of speech discriminations in infancy, preferential looking discriminations in word and argument structure learning, the development of morphological productivity, cue competition in learning and the nature of the language learning environment, would be greatly informed by attention to typological and cross-cultural differences. Without this, all theoretical approaches will be severely restricted in their applicability and, as a result, in their potential for generating a psychologically realistic account of the processes by which children learn to talk.

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CHAPTER 6

A typological approach to first language acquisition

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This paper will not simply be cross-linguistic, but typological, insofar as it refers to language types as constellations of typologically relevant linguistic properties. The general hypothesis is that children are sensitive to typological properties of the language they acquire, i.e. they are sensitive to the relative communicative importance and structure of linguistic patterns in their verbal interactions. This paper will focus on morphology as the backbone of holistic language typology. The data discussed will come especially from the collaborative results of the international "Cross-linguistic Project on Pre- and Protomorphology in Language Acquisition". The paper will concentrate on early phases of language acquisition and on inflectional morphology. The relevant properties are degree of morphological richness of a language, of transparency, uniformity and productivity. It is assumed that children will develop morphology faster, the richer the morphology is they are acquiring. They will also acquire transparent, uniform and productive patterns faster than opaque, non-uniform and unproductive ones. Among the three epistemological levels of typology, i.e. classificatory, ordering and quantitative typology, the paper will focus on the second level, where languages, and more precisely language subsystems, are ordered according to how closely they approach the ideal morphological types of, in our case, the agglutinating, the inflecting(-fusional) and the isolating type.

1. Introduction

This contribution is meant to report on intermediate results of joint project work on the acquisition of morphology in 14 languages and on how the linguistic perspective of ordering typology may explain cross-linguistic similarities and dissimilarities in acquisition. This typological approach follows the model of any comparative research in studying both *similitudo in dissimilitudine* and

dissimilitudo in similitudine and in assigning and presupposing comparable structures within the compared objects (Jucquois 1976).

The acquisition facts come from the "Crosslinguistic Project on Pre- and Protomorphology in Language Acquisition" (Dressler 1997; Dziubalska-Kołaczyk 1997; Gillis 1998; Voeikova & Dressler 2002; Bittner, Dressler & Kilani-Schoch 2003). This project studies in more than a dozen languages the acquisition of morphology up to the age of at least three years and collects, transcribes, codes (in CHILDES format, MacWhinney 2000) and analyses longitudinal corpora of children's spontaneous productions in strictly parallel ways. These corpora as well as our analyses include child-directed speech, which filters the adult language system for transmittance to the young child. I have to thank all researchers of this project, whose published and pre-published work I am using and citing here (see appendix). Since this contribution refers to different studies within the project, the longitudinal data used for each language differ both in number of children (sometimes only 1 child per language) and in the time periods of the corpora used.

The aims of this project are to arrive at (1) universal, (2) typological and (3) language-specific generalisations, in parallel to the functionalist grammatical model espoused, which is Natural Morphology (Dressler et al. 1987; Kilani-Schoch 1988; Kilani-Schoch & Dressler 2005; Dressler 2000, 2006) with its three subtheories of (1) universal preferences or universal markedness, (2) typological adequacy and (3) language-specific system adequacy. Since the first and third subtheory are only marginally referred to in this contribution, it may suffice to state that within the first subtheory universal, extralinguistically based morphological preferences have been elaborated such as the preference for an iconic, analogical correspondence between meaning and form relations and for a transparent concatenation of morphological units. The third subtheory has insisted on the difference between dominant and marginal structures within a language and between productive and unproductive patterns.

This contribution focuses on how properties of the second subtheory on typological adequacy render first language acquisition easier or more difficult.

2. Typology

The subtheory of typological adequacy has taken over many ideas from Skalička (1979, 2002; Kilani-Schoch & Dressler 2005), notably the concepts of linguistic types as ideal constructs which natural languages approach to various degrees. Thus these ideal types, despite their largely identical names, are not classes, such as the morphological types of classical morphological typology (Lehmann 1983;

Ramat 1995). In other words, languages like Turkish and Russian are not considered to be an agglutinative and an inflecting-fusional language, respectively, but Turkish is explicated to approach very much the theoretical ideal construct of the agglutinating language type, Russian to a lesser extent the construct of an inflecting-fusional language type. Within Natural Morphology, for each ideal construct of a language type, it is constitutive to which extent the universal preferences, e.g. for iconicity and transparency are followed. Furthermore, Skalička's concept that the inflectional and the word formation component of a language may behave differently typologically, must be extended to the subcomponents or submodules of inflectional morphology. Thus noun inflection and verb inflection may have a different typological character within the same language and develop diachronically in typologically different directions (this answers the critiques of Plank 1998 and Wurzel 1996 against the notion of language types). For example, Latin noun and verb inflection, which approach very much the inflecting-fusional type, have changed differently in Romance languages, particularly in French where noun inflection approaches closely the isolating language type, whereas verb inflection has retained much more an inflecting-fusional character. Old Slavonic has been similar to Latin, and Russian approaches the inflecting-fusional language type to a lesser extent, but it is more distant to it in verb than in noun inflection.

Due to the available longitudinal child-language data of our project as well as of the literature, I will deal with the ideal inflecting-fusional, the agglutinating and the isolating ideal language types of Skalička. As already indicated, we do not assign languages to one of these types (as if they were classes of languages), but order them according to the extent to which their noun or their verb inflection approach the ideal constructs of language types. In using concepts of ordering typology (epistemologically based on Hempel & Oppenheim 1936), the noun and verb inflection systems of the following languages can be ordered gradually in regard to inflectional morphology on the scales of closeness to (a) and (a') isolating ⟷ inflecting-fusional ideal type, (b) inflecting-fusional ⟷ agglutinating ideal type:

(a) Noun inflection:
French – Spanish – English – Dutch – Italian – German – Greek – Slavic languages – Lithuanian

(a') Verb inflection:
English – Dutch – German – Spanish – French – Italian – Slavic languages – Greek – Lithuanian

(b) Noun and verb inflection (in the same way):
Lithuanian – Slavic languages – Finnish – Hungarian – Turkish.

This means that, e.g., Lithuanian approaches most the inflecting-fusional type on all 3 scales in both noun and verb inflection, and that the isolating type is most approached by French in noun inflection (a), but by English in verb inflection (a'). On scales (a) and (a') one also calls the language systems to the right strongly inflecting-fusional, those to the left weakly inflecting-fusional.

In order to simplify the presentation, I'll use in this contribution only 3 main typological criteria: (a) morphological richness and the two universal preference parameters of (b) morphotactic transparency and (c) constructional iconicity:

a. Morphological richness refers to the amount of productive morphology: the isolating type is poor, the agglutinating type richest, the inflecting-fusional type less rich: thus French noun inflection is extremely poor, it has either no inflection on the noun at all or, rarely, unproductive inflection (as in *cheval* 'horse', PL. *chevaux*). French, Spanish, English, Dutch and Italian noun inflection have just one morphological category: number. In contrast, Turkish and Hungarian have 3 noun inflection categories: number, case and possession, and in Turkish the patterns expressing these categories are all productive. Languages which approach the ideal inflecting-fusional language type to a great extent, have many productive inflection classes, e.g. Russian verb morphology has 4 productive inflection classes, whereas English, Dutch and German only 1 (regular weak verbs, Dressler et al. 2006).
b. The universal preference parameter of morphotactic transparency classifies how much the ideal of morphological transparency is obtained by a particular morphological pattern. Pure concatenation of units without any formal obstacle for identifying these units is most transparent. Thus the English plural *brother-s* is transparent, because the units of the base (*brother*) and the plural suffix /z/ can be easily identified, whereas it is difficult to detect the base in the plural variant *brethr-en*, which therefore has little morphotactic transparency. In the agglutinating language type, the categories of number and of case are expressed separately, thus transparently, as in the Turkish plural dative *ev-ler-e* 'house-S-DAT', i.e. (e.g. I give) '(the) houses', whereas in the inflecting-fusional type number and case are expressed cumulatively, thus less transparently by a joint suffix, as in Russian *dom-am* 'house-DAT.PL'.
c. The parameter of constructional iconicity classifies how much morphotactic (form) markedness parallels morphosemantic (meaning) markedness. Thus in the category of number the meaning of the plural is in general marked, the meaning of the singular is unmarked. This is paralleled by the plural form of E. *brother-s*, because something is added to the singular form, but not in PL. = SG. *fish*. The agglutinating language type has constructional iconicity throughout (e.g. lack of zero plurals), the inflecting-fusional type does not.

The typological value of the concepts of agglutinating and inflecting-fusional morphology has been severely criticised by many specialists, such as Anderson (1985: 10), Bauer (1988: 170), Plank (1998), Haspelmath (2000), but cf. Bossong (2001), Plungian (2001). However these critics neither distinguished between morphological class and morphological type of languages nor did they consider the possibility that noun inflection, verb inflection, derivational morphology and compounding may be typologically different within the same language. Thus I claim that typology is more than cross-linguistic comparison and different from research in universals, both in general typology (here in accordance with Seiler's (2000) UNITYP model) and in child-language studies. This is linked to a claim, most vigorously defended by Coseriu (1970) within a structuralist framework, that typology is a basic and not an epiphenomenal level of accounting for linguistic generalisations.

Now, if typology is more than cross-linguistic comparison and different from research in universals, and if typology is a basic and not an epiphenomenal level of accounting for linguistic generalisations, then this means within a mentalist framework which takes morphological typology seriously, that typological generalisations of morphology are themselves basic. Since psycholinguistic claims by, e.g., Jakobson (1941) and accounts of empirical work on processing by, e.g., Zevin & Seidenberg (2002), Burani et al. (2001), Bonin et al. (2004) postulate that what is acquired early by a child is more basically represented in the adult system of representation and processing than what is acquired later, one may expect that basic typological generalisations should emerge early in first language acquisition.

Analogously, ceteris paribus, unmarked and universally preferred options should be acquired earlier than their respective marked correspondents, as already predicted by Jakobson (1941), cf. Mayerthaler (1981). More acquisitional predictions will be given at the end of the next chapter.

3. Developmental approach

Our developmental approach is constructivist (Maturana & Varela 1979; Karmiloff-Smith 1992; Karpf 1991): we do not assume that grammatical (sub)modules are genetically inherited (as is assumed in most generative acquisition paradigms) but that they are gradually constructed by the children themselves, i.e. that they construct a primitive system of grammar. When this global system, by accumulation of acquired patterns, becomes too complex, then it dissociates into modules of syntax and morphology, and later on the latter into submodules of inflection and word formation. This developmental model is integrated with the linguistic model, insofar as children's pattern selection and self-organisation is

considered to take the preferences of Natural Morphology into account (Dressler & Karpf 1995). This acquisitionist approach contrasts with emergentist approaches (Bavin 2009), including usage-based ones (Tomasello 2003), where universal linguistic preferences play a minor role, if at all.

Comparative acquisition studies in morphology which cover many languages, are rare and nearly always simply cross-linguistic, i.e. juxtaposing acquisition studies of each single language without comparing them in the sense of comparative typological linguistics or, if at all, only according to one contrastive variable each time (e.g. word order), with the notable exceptions of parts of Slobin's (1985, 1997) seminal work and of Peters (1997).

We divide early morphological development into three subsequent phases:

a. Premorphology, a rote-learning phase in which the child's speech production is limited to a restricted number of lexically stored inflectional forms of little relevance for our topic.
b. Protomorphology, a phase in which the child starts to generalise over rote-learned forms, thereby detecting the morphological principle of (de)composing form and meaning word-internally.
c. Morphology proper or modularised morphology, where (according to Dressler & Karpf 1995) the child constructs (sc. non-innate) modules and submodules and acquires a qualitatively adult-like morphology which already possesses all of its basic typological properties.

Our predictions on the influence of typological factors on earlier vs. later emergence of morphological patterns refer to the phase of protomorphology, because basic typological generalisations are expected to emerge early (§2) but cannot before the morphological principle of (de)composing form and meaning is detected. More specifically we predict that:

– Morphosemantically unmarked forms emerge before corresponding marked ones (e.g. singulars before plurals, unless the noun is plural-dominant, such as words for Easter eggs).
– Morphotactically more transparent patterns emerge before corresponding less transparent ones.
– Patterns with a higher degree of constructional iconicity emerge before corresponding patterns with less iconicity.
– Greater morphological richness of an inflectional system stimulates children more than poorer ones.
– Based on the third subtheory of Natural Morphology (on language-specific system adequacy) we predict that productive morphological patterns are taken up more easily by children than unproductive ones, in the sense of

identifying and even overgeneralising patterns (as with English regular weak verbs).
– Finally we include the general acquisitionist prediction that phonologically more salient patterns are more susceptible to be taken up by children than corresponding less salient ones (Peters 1985; Gillis 2003: 196–199).

These predictions will be specified more in detail in the following chapters.

4. First typological differences in acquisition

The first typological differences emerge already in premorphology: in reaction to, and in accordance with, the maternal or other adult input, the child selects and stores morphological patterns of high token frequency and which occur in the basic syntactic patterns that the child has taken up from the input. These patterns largely consist of morphosemantically unmarked forms, such as nominative singulars of singular-dominant nouns, plurals of plural-dominant nouns (e.g. G. *Haar-e* 'hair', *Ei-er* 'eggs'), infinitives, singular imperative, first or third singular present forms (particularly of atelic verbs). This has typological implications, for example whether these forms are in an iconic way zero-base forms (Peters 1997: 179f.; Croft 2003: 162f.), such as 3.SG.PRES in Turkish, Hungarian, Finnish, Lithuanian, Polish, Croatian, Spanish, French and, partially, Italian, or not, as in German, Russian, Greek. If, however, the 3.SG.PRES form is affixed, whereas the first and second persons are in an anti-iconic way zero-base forms, as in English and Dutch, then the 3.SG.PRES emerges later (Bittner et al. 2003). This is a cross-linguistic manifestation of the above-mentioned principles "unmarked before marked" and more iconic forms earlier than less iconic ones.

There is a second typological option in the 3.SG.PRES as base form, namely whether it has a thematic vowel or other stem indicator (a property of the inflecting-fusional type), as in Lithuanian, Polish, Croatian, Spanish, Italian, or not, as in agglutinating Turkish, Hungarian, Finnish and in more isolating French (Dressler, Kilani-Schoch, Spina & Thornton 2003; Dressler & Kilani-Schoch 2004). In the second case, the child can start and often does focus on an uninflected form, in the first case all first forms of verbs are in some way inflected (Kilani-Schoch 2003: 288).

Even closely related and similar languages may differ typologically.Thus in Spanish, but not in Italian, the 3.SG.IND is always identical with the 2.SG.IMP, e.g. *habla* '(s)he talks, talk!". As a consequence, in Spanish-learning children this default form always emerges very early and is dominant, whereas in Italian children the 3.SG competes with the 1.SG.

What is typologically most important, is the degree of morphological richness of a language, i.e. of productive morphology. In morphologically rich languages morphology fulfils more functions, already visible in more form-meaning mappings (Slobin 1973, 1985, 2001) and hence is more "informative" (Wijnen et al. 2001) than in morphologically poorer languages. This is most obvious in Turkish, where the role of morphology is much greater, and correspondingly the role of syntax smaller, than in inflecting-fusional languages and particularly in weakly inflecting-fusional languages which share properties of the isolating type. Children become aware of the respective role of morphology in the language they are acquiring, i.e. they are more "tuned" to morphology if they are acquiring a morphology-rich language. Thus we can expect (Slobin 1985) that such children should detect morphology earlier than children acquiring morphologically poorer languages.

But how can we identify detection of morphology by children (Dressler, Kilani-Schoch & Klampfer 2003)? For this purpose Kilani-Schoch & Dressler (2002) have elaborated the criterion of the emergence of miniparadigms, i.e. incomplete paradigms (from the adult perspective). For example, the first miniparadigm produced by the Viennese boy Jan at 1;10 (Klampfer 2003: 314) is shown in (1):

(1) INF *machen*, 3.SG.PRES.IND *macht*, PPP *gemacht* 'to make'.

Now the miniparadigm criterion states that whenever we find three lemmas of the same word class of which three morphotactically and morphosemantically clearly distinct paradigm members have emerged and recurred in spontaneous production in various contexts, then we can safely assume that such a child has enough pattern variety in its uptake in order to detect the morphological principle of (de)composing form and meaning word-internally. This principle then appears soon to be extended from bound morphology to the morphology of (generally) monomorphemic function words, i.e. bound morphology, especially productive (bound) morphology, tends to develop faster than free morphemes, i.e. function words (Dressler, Kilani-Schoch & Klampfer 2003; Peters 1997: 180). Thus we hypothesise that the time point of the emergence of form oppositions is determined by the degree of morphological richness of the respective target language, including greater morphotactic transparency and constructional iconicity.

In support of this hypothesis, for verb inflection the miniparadigm criterion has been observed to be fulfilled for Turkish at 1;7 (Aksu-Koç & Ketrez 2003; first verb oppositions even at 1;5), for English after 2;5 (Gülzow 2003; de Villiers & de Villiers 1985); for the early emergence of Turkish morphology in general, see Aksu-Koç & Slobin (1985), Ketrez & Aksu-Koç (2009), Stephany (2002), Voeikova (2002). At first sight this result may seem paradoxical, because it should be much

easier to acquire the very poor inflectional systems of English than the very rich inflectional systems of Turkish. What appears to be much more important for the child than superficial simplicity, is the much greater usefulness of acquiring inflectional morphology in Turkish than in English, plus the great difference in orderly variation (in terms of transparency, iconicity and productivity) available in the respective inputs.

If we now compare agglutinating with strongly and weakly inflecting-fusional languages, we must keep in mind that for each language the miniparadigm criterion has been investigated only for very few children (Bittner et al. 2003) and that no such gross differences have been found as between Turkish and English (cf. also Stephany 2002 for the emergence of nominal number). Still it is compatible with our hypothesis that the miniparadigm criterion has been fulfilled at the same age as with Turkish only with one Finnish child (at 1;8 with the other), i.e. solely for the other strongly agglutinating language of the language sample in Bittner et al. (2003). These two agglutinating languages are rather closely followed (at 1;10) by Lithuanian nouns and verbs (Wójcik 2000, 2003), Croatian and Spanish verbs (rather strongly inflecting systems), and for verbs by one Italian boy (Dressler, Tonelli et al. 2003), by one French-learning girl (the other at 2;1), followed by Greek (1;11). Yucatec Maya, Russian, Italian (except the afore-mentioned boy), German and Dutch come later.

Supporting evidence comes from an experimental constrastive study by Niemi & Niemi (2006) of plural formation of pseudo-words by Finnish and Swedish children: children acquiring rather agglutinating Finnish were better and more precociously than children acquiring weakly inflecting Swedish.

Our project results presuppose that we distinguish, as proposed above, within each language, different morphological systems. For example, in French, the noun system is of a very isolating type, the verb system much less. Thus it is French verbs where children first must detect morphology, whereas in German it is noun inflection and noun-compounding as well (Dressler, Kilani-Schoch & Klampfer 2003), since much more different inflection patterns in noun morphology are productive and show inflecting-fusional characteristics than in verb morphology.

For example, the Austrian boy Jan produces at the onset of protomorphology (1;8) first oppositions between compounds and their members: *Feuer(wehr)auto* 'fire(brigade)-car' and simplicia *Auto* 'car', *Feuer* 'fire', compound *Doppeldecker-bus* 'double-decker-bus' and its member *Doppeldecker* 'double-decker', compound *Segelschiff* 'sailing-boat' and simplex *Schiff* 'boat'. With 1;9, first examples of analogy appear, which give evidence for Jan's creative use of compound formation. The recurrence of nouns within compounds and as autonomous words must have induced him to identify the basics of compounding. Among all languages of our project, only German compounding appears rich enough for stimulating children

to use compounds productively at an early age. This represents further evidence for Skalička's (1979) view that different subcomponents of morphology may approach different ideal language types.

5. Language types

The inflecting-fusional type differs from the agglutinating type in having a complex hierarchical branching system of inflection classes (Dressler 2003; Dressler et al. 2006), whereas the ideal agglutinating type has none. Thus (Pöchtrager et al. 1998) nearly all Turkish nouns and verbs inflect each according to a single pattern, Hungarian has few and hierarchically rather shallow class differences, Finnish already more, whereas Estonian is also in this respect rather an inflecting-fusional language, similar to Italian verb inflection.

As a consequence, in Turkish, diminutives (Savickiene & Dressler 2007; Savickiene et al. 2007) inflect in the same way as any other common noun, whereas in all the other diminutive-rich languages (derivationally) productive diminutives belong to the productive inflectional classes. For example, It. *tribù* 'tribe' is indeclinable, *poeta* 'poet', *amico* 'friend', and *pelle* 'skin' belong to unproductive inflection classes, whereas their diminutives *tribu-ina, poet-ino, amich-etto, pell-icina* belong to productive inflection classes. Since, ceteris paribus, productive patterns have a higher chance to be taken up by children than unproductive ones (Dressler et al. 1996; Smoczyńska 1985: 624f.; Peters 1997: 180f.), diminutives of simplicia belonging to unproductive classes emerge earlier than their simplex bases and thus diminutives appear to help children to acquire inflection (Gillis 1998; Savickiene 2003; Savickiene et al. 2007; Savickiene & Dressler 2007). This effect does not exist in Turkish.

In languages approaching the inflecting-fusional language type, diminutives tend to belong to classes which are morphotactically very transparent, compare the Italian non-transparent plurals *ami*[k]*o*, Pl. *ami*[č]-*i*, *uomo*, Pl. *uom-ini* 'man', but the respective diminutives have more transparent plurals: *amichetto, amichetti; omicino, omicini*. Again morphotactic transparency, similar to productivity, is known to facilitate early acquisition (Slobin 1985: 1216; Peters 1997: 181; Savickiene 2003; Aksu-Koç & Slobin 1985: 847; Savickiene et al. 2007).

A result of these intra-linguistic and cross-linguistic differences in morphotactic transparency is that children acquiring languages which approach the inflecting-fusional or the introflecting language type (i.e. Semitic languages), after having detected morphology, tend to overgeneralise productive, and later even unproductive but more transparent patterns, such as Fr. *prendre* 'take', PP *pris* →

prend-u, after *rendre, rendu* (Kilani-Schoch 2003), a procedure which is scarcely possible in a very agglutinating language.

A noteworthy result of our project has been the finding (Voeikova 2002; Stephany 2002; Stephany & Voeikova 2009) that case distinctions appear to emerge in languages approaching the agglutinating type before number distinctions, whereas in strongly inflecting-fusional languages case distinctions emerge after number distinctions (exception: Lithuanian, Savickiene 2003). Number is a more basic category than case. One can propose even an implication: if a language has case distinctions, it also has number distinctions, but not vice versa. Thus we can expect number to emerge earlier in acquisition than case. Now why is there the reverse order in the acquisition of, at least, Turkish, Finnish and Hungarian? Plural and case are marked separately and transparently in these languages and case after plural, e.g. in Turkish (2):

(2) N.SG ev 'house', N.PL ev-ler, LOC.SG ev-de, LOC.PL ev-ler-de

Thus, in case of a plural oblique case form, it is easier for the child to strip off the case suffix than the plural suffix. Moreover, due to the recency effect, ends of words are easier to segment than beginnings (Slobin 1973: 191f.; Peters 1997: 181f.; Kirk & Demuth 2005), which appears to be also the main reason for the general suffixing preference (Hall 1992). Also in our project languages suffixes emerge earlier than prefixes.

6. Conclusion

There is a close connection between morphological and syntactic properties in linguistic typology, and consequently Skalička's ideal types are characterised both by morphological and syntactic properties. Such close connections, provided that they are viewed as pertaining to a basic typological level of language, present a problem to a nativist modular approach whereby morphology and syntax are identified as different innate modules, because interaction between different modules is limited to their superficial outputs but banned from their basic design. However, since we assume, and have found evidence for, that basic typological properties are acquired in the protomorphological phase, i.e. before the modules of morphology and syntax are dissociated, this problem does not exist for our constructivist approach. In protomorphology the emerging but not yet modularised components of morphology and syntax can freely interact. In this way data from first language acquisition can support the approach to typology as a basic level of language.

The concepts and acquisitional evidence discussed in this contribution demonstrate the mutual relevance of early language acquisition and linguistic typology, at least in its format of ordering language typology. In our project we are currently working on relating morphology acquisition to quantitative language typology, which is epistemologically superior to ordering typology. The intermediate results are discussed in Laaha & Gillis (2007).

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Appendix

Languages and researchers responsible for the longitudinal acquisition data of the "Crosslinguistic Project on Pre- and Protomorphology in Language Acquisition" in the publications cited:

Croatian:	Melita Kovačević, Marijan Palmović (Zagreb), Antigone Katičić (Vienna)
Dutch:	Steven Gillis (Antwerp)
Finnish:	Klaus Laalo (Tampere)
French:	Marianne Kilani-Schoch (Lausanne)
German:	Wolfgang U. Dressler, Sabine Laaha, Katharina Korecky-Kröll (Vienna), Dagmar Bittner (Berlin)
Greek:	Ursula Stephany (Cologne), Anastasia Christofidou, Evangelia Thomadaki (Athens)
Hungarian:	Péter Bodor, Virág Barcza (Budapest)
Italian:	Sabrina Noccetti (Pisa), Anna de Marco (Cosenza), Livia Tonelli (Genova)
Lithuanian:	Ineta Savickiene (Kaunas), Paweł Wójcik (Vilnius)
Polish:	Katarzyna Dziubalska-Kołaczyk (Poznan), Dorota Kiebzak-Mandera (Cracow)
Russian:	Maria Voeikova (St. Petersburg), Natalia Gagarina (Berlin), Elena Protassova (Moscow)
Spanish:	Carmen Aguirre, Victoria Marrero (Madrid)
Turkish:	Ayhan Aksu-Koç (Istanbul), Nihan Ketrez (Yale)
Yucatec Maya:	Barbara Pfeiler (Merida)

CHAPTER 7

Linguistic relativity in first language acquisition

Spatial language and cognition

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The relationship between language and cognition is perhaps one of the oldest questions in the history of social and cognitive sciences. This question is presently at the center of lively debates in light of a growing number of cross-linguistic studies suggesting that language-specific factors could have an impact on language acquisition and even more generally on cognitive organization. This chapter illustrates some results in the domain of space, with particular attention to the expression of motion in two languages (French and English) that lexicalize spatial information in different types of structures (Talmy 2000). The synthesis of these results shows striking cross-linguistic differences in how adults and children (two to ten years) express different types of voluntary and caused motion events in a variety of situations, indicating that typological constraints affect how children organize information from the youngest age onwards. The discussion points to ongoing research that further explores the language-cognition interface in order to examine the potentially deeper impact of language-specific factors on speakers' conceptual representations of space.

1. Introduction: Language and cognition

The fundamental question of how to relate language and cognition remains controversial. Proposals diverge with respect to a number of related but distinct assumptions. One point of divergence concerns whether language should be viewed as constituting a special type of knowledge that is autonomous from other sources of knowledge or whether it entertains an intricate relation with other forms of cognition, the nature of which must be determined. Furthermore, some proposals focus on implications of the considerable diversity that is displayed

across languages of the world, while others aim at discovering universals by uncovering similarities assumed to underlie these linguistic variations.

The Chomskyian position best illustrates one type of 'universalistic' view, according to which linguistic competence constitutes an autonomous module of knowledge that is biologically pre-programmed, specific to the domain of language, and independent of other types of knowledge. In contrast, other universalistic approaches postulate a tight relationship between language and cognition following a general principle of 'cognitive determinism', according to which some constraints stemming from the architecture of the cognitive system would account for recurrent patterns in language acquisition. Thus, the Piagetian tradition assumes that cognitive development constitutes the main force driving the acquisition of all knowledge, including language, which follows regular stages determined by changes in the child's cognitive structure. Other models postulate more specific cognitive constraints, for example constraints that are linked to early event conceptualization (Slobin 1985) and/or to cognitive processes underlying language use in real time (MacWhinney & Bates 1989).

Following a principle of 'linguistic determinism', human language can also be viewed as a symbolic system that partially structures human cognition. The nature of this structuring process differs depending on whether models focus on universal properties of human language and/or on language-specific properties that are variable across linguistic systems. Classical examples of these two views can be found in Vygotsky's (1962) theory of cognitive development and in Whorf's writings 1956) concerning the implications of linguistic relativity (see overviews in Hickmann 2003; Gumperz & Levinson 1996; Lucy & Wertsch 1987). Vygotsky highlighted universal properties of human language that make it a special and powerful tool for action, particularly its multifunctionality as a symbolic system enabling *both* representation and communication. According to him, language provides a layer of *semiotic mediation* in human cognition that accounts for the emergence of higher and specifically human cognitive functions on both phylogenetic and ontogenetic scales. The Whorfian tradition is compatible with Vygotsky's theory but goes beyond it. Taking linguistic diversity as its starting point, it puts forth the hypothesis that particular properties of linguistic systems affect speakers' *world view* and *habitual behaviour*. Recent versions of this view concerning child development suggest that languages provide filters that channel incoming information making some aspects of reality more or less salient and accessible to the child, thereby influencing how they construct categories, process information, and organize discourse.

We illustrate below some of these questions in the domain of space, with particular attention to the expression of motion events. The representation of space presents a striking paradox which is of particular relevance in the context of the

debates concerning the language-cognition interface. Although it constitutes a most basic and fundamental domain of human cognition, spatial systems show a considerable degree of variability across languages, which seems to affect speakers' behaviour from the youngest age to adulthood. This variability opens new directions for the study of language acquisition and perhaps for future research concerning potentially deeper implications for cognition.

1.1 Motion across languages: Lexicalization and grammaticalization

During the last fifteen years, researchers (Gumperz & Levinson 1996; Levinson & Wilkins 2006; Lucy 1992; Nuyts & Pederson 1997) have repeatedly shown some considerable variations across languages that have revived fundamental questions about human cognition. One dimension concerns the relationship between syntax and the lexicon, an old question that has emerged again in light of recent linguistic and psycholinguistic research in several domains. In this respect, the linguistic representation of space has been of particular interest, whether in relation to static spatial relations or to dynamic space, for example in the expression of motion that will be our focus below.

In order to represent motion, all languages distinguish two types of events: motion that takes place within a general location (e.g. the garage in example (1)) versus motion that implies a change of location (e.g. from outside to inside in example (2)). However, this distinction is marked in very different ways across languages. As illustrated in (1) and (2), English verb roots typically express the manner with which motion is carried out (e.g. *run*), while other markers encode its path, distinguishing general locations from changes of locations (e.g. *in* vs. *into*). As shown in (3) and (4), French behaves differently depending on these two types of events. French (3) is structurally similar to English (1), but (4) differs from (2): the verb lexicalizes path (*entrer* 'to enter'), while manner (if it is mentioned at all) is expressed in the periphery of the sentence (adverbial or subordinate clause with a gerund).

(1) He is running in the garage.

(2) He ran into the garage.

(3) *Il court dans le garage*.
Lit.: 'He runs in the garage.'

(4) *Il est entré dans le garage en courant*.
Lit.: 'He entered in[to] the garage running.'

On the basis of such differences, Talmy (2000) proposes a typological distinction between two main language families, 'satellite-framed' and 'verb-framed' languages (hereafter S- and V-languages), illustrated by the contrast between Germanic vs. Romance above. These languages differ in the kinds of structures they provide, particularly in cases such as (2) and (4). Thus, among other distinguishing features, S-languages provide more compact structures for the simultaneous expression of different types of information in comparison to V-languages.

These organizational principles correspond to linguistic 'prototypes', that do not exclude other grammatical means of expression within a given language, but that invite strong preferences on the part of speakers. Thus, French clearly allows utterances such as (5) that express manner in the verb and path in spatial prepositions. However, such utterances are pragmatically more marked than (4) above, indicating for example that the path has been entirely covered in some unusual manner. Some French verbs can also lexicalize both manner and path (e.g. *grimper* 'to climb up'), but few are frequent in common oral speech. Finally, French has a sub-system of verbal prefixes such as those in (6) that share some properties of satellites, although this sub-system is not productive, in comparison to the highly productive satellite systems of S-languages (Kopecka 2006).[1]

(5) *Jean a sauté à cloche-pied jusque dans le garage*.
'John jumped on one foot all the way to the garage.'

(6) *écrémer, transporter, traverser, atterrir, accourir …*
'to take cream off', 'to transport', 'to cross', 'to land', 'to run quickly to'…

Finally, it must be noted that these typological differences affect other domains beyond spatial language. In particular, as illustrated in English (7) and (8), they account for the existence of causative-resultative constructions in S-languages that do not exist as such in V-languages, as shown by the incomplete, awkward, and less compact translations of these examples in French (9) and (10).

(7) He sneezed the papers off the table.

(8) He hammered the lock open and kicked the dog out.

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1. With the exception of some common verbs such as *grimper* ('to use limbs in an upwards direction' = 'to climb up'), most French verbs that simultaneously lexicalize manner and path belong to a higher register and are rare in daily oral speech (e.g. *accourir* 'to run quickly to', *dévaler* 'to come down quickly'). With respect to (6), note that during its diachronic history French evolved from an S-system to a V-system. Contemporary French now only displays limited combinations between prefixes and verbal roots with a restricted number of morphemes, most of which do not constitute autonomous lexical entries.

(9) *Il a fait tomber les papiers de la table en éternuant.*
Lit.: 'He made the papers fall from the table by sneezing.'

(10) *Il a ouvert la serrure avec un marteau et a donné des coups de pieds pour faire sortir le chien.*
Lit.: 'He opened the lock with a hammer and gave kicks to make the dog exit.'

1.2 Cognitive implications

Psycholinguists have begun to explore the potential cognitive implications of this linguistic diversity, particularly in the domain of space (see a review in Hickmann 2003). This most basic domain of behaviour has been assumed until recently to be entirely governed by universal factors determining human spatial cognition. In some developmental theories (e.g., Piaget's), it even constitutes a fundamental building block for how the child constructs representations of the world. In addition, infant research (see Spelke 2000) now suggests the existence of very early knowledge about the properties of objects and the physical laws that govern their displacements (a few months after birth). Such results have led to some debates concerning the innate and modular nature of this knowledge vs. the more general perceptual and cognitive learning mechanisms that may be responsible for its early emergence and further development. Some models (Jackendoff 1996; Landau & Jackendoff 1993) have also proposed that all languages differentiate two systems (the *What* and *Where*), respectively dedicated to the identification of entities and to their location in space, that seem to reflect corresponding neuronal infrastructure.

As briefly illustrated above, however, the striking linguistic diversity that can be found across spatial systems is puzzling and has been treated in two ways: either as merely corresponding to superficial differences 'hiding' deeper universal structures to be uncovered or as an important fact in itself that raises fundamental questions concerning some postulated universals. A first way to address this question is to determine whether language-specific factors influence the developmental course followed by children during first language acquisition. A second more general question is the extent to which language may significantly affect all of our spatial representations, beyond the production of spatial language, by influencing not only our verbal behaviours but also our deeper underlying non-verbal representations of space. From a developmental perspective, these questions bear on whether the development of spatial cognition proceeds in a continuous manner from birth on or whether it implies some reorganization during children's construction of language.

Ongoing research has begun to test these different hypotheses in various ways. This research includes further studies of infants developing in different linguistic environments (Bowerman & Choi 2003; Hespos & Spelke 2004, 2007), which presently show divergent results with respect to the earliest age at which language effects may be observed in development. Other studies have focused on various types of relevant pathologies, such as dissociations between verbal and non-verbal spatial cognition in Williams syndrome (Landau & Lakusta 2006; Pléh, this volume) or between lexical and syntactic knowledge in aphasia (Soroli et al. 2009). Finally, a growing number of studies have examined children's first language acquisition in a cross-linguistic perspective, to which we now turn.

2. The acquisition of spatial language

Numerous previous studies on children's spatial language have reported recurrent developmental progressions, presumed to reflect universal stages of cognitive development (see a review in Hickmann 2003). However, with few exceptions (e.g. Johnston 1988; Johnston & Slobin 1979), most consisted of examining a single child language or at best a couple of closely related languages, on the basis of which claims were made about universal stages of development. In the last twenty years or so, a growing number of studies have begun to systematically compare children's acquisition of spatial language across different languages and this cross-linguistic perspective has lead to different conclusions (Bowerman 1996, 2007; Choi & Bowerman 1991; Hickmann 2003; Hickmann & Hendriks 2006, 2010; Hickmann, Bonnet & Taranne 2009; Hickmann et al. 2010; Hickmann, Hendriks & Champaud 2008; Slobin 1996, 2006).

With respect to children's representations of motion, cross-linguistic analyses of narrative productions (Berman & Slobin 1994; Hickmann 2003; Slobin 1996, 2004, 2006) show that speakers (adults and children from three years on) organize discourse in different ways depending on their language. In S-languages (e.g. English, German, Turkish, Chinese), they provide detailed information concerning motion and little information concerning locations. Conversely, in V-languages (e.g. French, Spanish, Hebrew), dynamic information is less detailed but strongly anchored in static information about locations. In light of these results, Slobin proposes that the prototypical lexicalization patterns within a given language have an impact on language acquisition, as well as on the processes whereby children learn to organize the flow of incoming information in discourse. His hypothesis (*thinking for speaking*) is that, when engaged in verbal communication, our thinking processes are influenced by the activity of speaking, so that both speaking and thinking are strongly linked to language-specific properties.

In this context, few studies are still available concerning the acquisition of spatial language in French, despite the particularly interesting status of this language in a cross-linguistic perspective. We synthesize here some of our research that compares the expression of motion in French vs. English child language. This research includes some experimental studies carried out with adults and children from three years on, as well as longitudinal analyses of spontaneous productions by younger children during the emergence of language and early phases of language acquisition. In all data bases analyses focused on several dimensions of children's productions, including how much information was expressed (hereafter *semantic density*), as well as the nature of the content expressed (*focus*) and the linguistic means used, with particular attention to whether information was lexicalized in the verb or expressed in other devices (*locus*).[2] On the basis of typological properties, our predictions were that utterances about motion should be semantically denser in English as a result of the greater availability of compact structures allowing the expression of more types of information as compared to French. In addition, it was predicted that these typological differences should influence productions at all ages, despite possible developmental progressions linked to the simultaneous development of more general cognitive capacities.

2.1 Voluntary motion

A series of studies examined descriptions of voluntary motion events. Adults and children between three and ten years were asked to describe short animated cartoons (24 items) showing spontaneous displacements carried out voluntarily by various characters along three different Paths (up, down, across) and in various Manners (swimming, running…). The results of a first study comparing English and French descriptions in some age groups (Hickmann, Bonnet & Taranne 2009) were later replicated in these two languages and complemented by the inclusion of other age groups, as well as extended to other languages such as German and or Chinese (Ji 2009; Ochsenbauer 2010; Ochsenbauer & Hickmann 2010; see an overview in Hickmann et al. 2010). Table 1 synthezises the main results across these studies, focusing on French and English (collapsing item types) by showing the general distribution of responses expressing Manner only (M), Path only (P),

2. 'Other' devices included all linguistic means used outside of the main verb and/or in subordinate clauses, such as: particles (in English, e.g. *down*), as well as prepositions (e.g. *sur* 'on', *dans* 'in[to]'), adverbial expressions ([tirer] *avec une corde* '[to pull] with a rope', *to push together*, *coller ensemble* 'to glue together'), and subordinated gerunds (*en collant* 'by glueing, *en marchant* 'by walking').

or both Manner and Path (MP), as illustrated in simplified examples (11) to (14) (relevant elements in bold). The ranges of percentages in this table highlight the main patterns that were observed by dividing the distribution into four quarters differentiated below as responses that were *predominant*, *very frequent*, *less frequent*, and *infrequent*.[3]

(11) Il **a nagé** [M]. [M-response]
'He swam.'

(12) Il **a traversé** [P] la rivière. [P-response]
'He crossed the river.'

(13) He **swam** [M] **across** [P] the river. [MP-response]

(14) Il **a traversé** [P] la rivière **à la nage/en nageant** [M]. [MP-response]
Lit. 'He crossed the river by the swim/by swimming.'

Table 1. Most frequent patterns in descriptions of animated voluntary motion events (based on Hickmann et al. 2009, 2010)[a]

Age	English	French
Adults	MP***	MP*, P**
10 years	MP***, P-	MP-, P**
8 years	MP***, P-	MP-, P**
7 years	MP**, P*	MP*, P**, M*
6 years	MP**, P*	MP-, P**, M-
5 years	MP**, P*, M-	MP-, P**, M**
4 years	MP*, P*, M-	MP-, P**, M*
3 years	MP*, P*, M*	MP-, P**, M**

[a] M = Manner only, P = Path only, MP = Manner + Path.
*** Predominant = 75% or over
** Very frequent = 50% and over but under 75%
* Less frequent = 25% and over but under 50%
- Infrequent = under 25% excluding responses under 10%

3. The aim of the present synthesis is to highlight main response patterns extracted from a number of studies, all based on a similar experimental procedure, but involving different age groups and slightly different designs (e.g. within- vs across-subject design with respect to items types, item order, other items and tasks). For the purposes of this presentation, percentages were divided as follows (detailed analyses can be found elsewhere):

*** *predominant* = 75% and over;
** *very frequent* = 50% and over but under 75%;
* *less frequent* = 25% and over but under 50%;
- *infrequent* = under 25% (rare responses under 10% not included).

In English MP-responses were predominant (eight and ten years, adults) or very frequent (five to seven years), although the youngest children (three and four years) also produced as frequently some responses focusing on Manner or on Path alone. At all ages English MP-responses systematically expressed Manner in the main verb root and Path in other devices (e.g. ((13)). Other responses among children encoded only Manner in the verb (*to swim*) or only Path in other devices (*go up*) and occasionally in the verb (*to cross*). French responses were more varied and showed no overall predominant pattern. However, P-responses were the most frequent at all ages in French including among adults and consisted of using a Path verb with no information about Manner (e.g. (12)). A second response type consisted of using a Manner verb (M-responses such as (11)), particularly among children before age eight, where it fluctuated from being very frequent (three and five years) to less frequent (four and seven years) or infrequent (six years). As for MP-responses (e.g. (14)), they were significantly less frequent in French than in English at all ages, from three years on and including among adults. These responses mostly occurred among adults and/or were generally less frequent than other responses at all ages. Note that French adults produced MP-responses more frequently than French children, but much less frequently than English speakers from five years on. Finally, it should be noted that some variations occurred in both languages as a function of event types. French children's MP-responses to upward motion frequently involved the verb *grimper* ('to climb up') that lexicalizes Path and Manner in descriptions of upward motion (see Note 1). Furthermore, an unexpected result in both languages was that children's M-responses concerned almost exclusively crossing events (e.g. (11)). In contrast, adults' responses to these items expressed either Path (especially in French) or both Manner and Path (especially in English).

In summary, the results show a similar developmental progression with respect to semantic density in both languages, as well as variations across event types. Nonetheless, notwithstanding the effects of these factors, Manner+Path responses were significantly more frequent in English than in French at all ages, resulting in a higher semantic density at all ages.

2.2 Caused motion

Two more studies extended these results to the expression of caused motion. In one of these studies (Hickmann & Hendriks 2006) subjects had to describe actions (20 items) that were performed in front of them and that consisted of displacing

one object (figure) to a new location (ground).[4] These actions varied across four types of items, consisting of: putting the figure on top of an entity (ONTO, e.g. putting a top onto a pan); putting various clothes onto a doll (CLOTHES, e.g., a hat, a jacket); loosely putting the figure into a container (INTO, e.g. putting a toy into a large box); adjusting tightly fitting objects with one another (FIT, e.g. putting Lego pieces together). In order to analyze the responses (see examples (15) to (21), relevant elements in bold), we examined the linguistic means that were used to express various types of specific information (e.g., manner of attachment, manner of causing displacements, path, resulting location).[5] Particular attention was placed on whether this information was encoded in verbs and/or in other devices (see Note 2) resulting in the following possibilities: verb only (V), other devices only (X), both (VX) or neither (0). The last response type mostly concerned three-argument structures used with CLOTHES-items in which the ground entity was presented as an indirect object rather than as a location (e.g. (20)), as well as vague responses produced by children (e.g., (21)).

(15) Tu **accroches** la veste (au porte-manteau). [V = specific attachment]
('You are hooking the jacket on (at the coat rack).')

(16) Tu as mis la veste **sur** le porte-manteau. [X = location]
('You put the jacket on the coat rack.')

(17) Tu **fermes** la casserole. [V = spatial-functional configuration]
('You close the pan.')

(18) You put the toys **into** the box. [X = Path]

(19) You're **attaching** the hook **onto** the wall. [VX / V = vague attachment + X = path]

(20) Tu lui mets une veste. [0]
'You [to]her put a jacket.'

4. I thank Melissa Bowerman for lending me stimuli (Bowerman 1996, 2007), a subset of which were included in this study. Actions consisted of 'putting' an entity at a new location and were followed by the action of 'taking off' this entity away from its resulting location. Subjects also performed a static location task on the basis of pictures. A corpus is presently in progress among English children and complementary corpora are now available among German adults and children.

5. Some prepositions (*at*, *à* 'at/to') and verbs (*to put*, *mettre*) are quite neutral and can be used in many contexts. Coding identified linguistic means that expressed relatively 'specific' relevant information, including manner (e.g., *to hang*), path when motion implied a change of location (*into*), and general resulting locations (*sur, on*).

(21) Tu mets un couvercle. [0]
'You put a cover.'

Table 2 summarizes the results concerning information locus as a function of item types. It shows language differences in adults' preferred patterns, as well as variations across items types in both languages. INTO-items elicited frequent X-responses (predominant in English, very frequent in French), whereby speakers of both languages expressed relevant information in devices outside of the verb (particles, prepositions, adverbials). With other items, however, adults showed partially divergent patterns. English speakers showed a preference for encoding information outside of the verb (X-pattern), especially with CLOTHES-items (predominant pattern) and with ONTO-items (very frequent pattern), and these responses also occurred with FIT-items (less frequent pattern). In comparison, French speakers showed a preference for encoding information in the verb alone (V-pattern), especially with FIT-items (very frequent pattern), but also with CLOTHES- and ONTO-items (less frequent pattern). Additional responses in both languages involved encoding information both in the verb and in other devices (VX-pattern), particularly with ONTO- and with FIT-items, although these responses constituted a less frequent pattern in both languages.

More generally, French adults frequently tended to express relevant information in the verb (e.g., *accrocher* Lit. 'to hook'), which was typically used either alone or with a neutral preposition (namely *à* 'at'), and less frequently with more specific prepositions (such as *sur* 'on'). In contrast, English-speaking adults mainly expressed relevant information outside of the verb (X) most often with a neutral verb (*put into*), notwithstanding some infrequent responses that contained more specific verbs (e.g. *to glue onto*). Finally, qualitative analyses of verb

Table 2. Most frequent patterns in descriptions of mimed object displacements (based on Hickmann & Hendriks 2006)[a]

	English adults	French adults	French children
Into	X***	X**, VX-, V-	X**, V-, 0-
Clothes	X***, VX-	X*, VX-, V-	X*, 0**
Onto	X**, VX*, V-	V*, X*, VX*	V*, 0*, X-, VX-
Fit	X*, VX*, V-	V**, VX*	V**, X-, 0-

[a] Linguistic means expressing relevant content: V = verb only, X = other devices only, VX = both, 0 = neither.
Other devices = all motion-relevant devices outside of the main verb and/or in subordinate clauses.
*** Predominant = 75% or over
** Very frequent = 50% and over but under 75%
* Less frequent = 25% and over but under 50%
- Infrequent = under 25% excluding responses under 10%

semantics also show that French verbs mostly focused on a specific Manner of attachment (*coller* 'to glue', *accrocher* 'to hook'…) and/or in some cases on the resulting global spatial-functional configuration of entities (*fermer* 'to close', *couvrir* 'to cover'). English verbs also expressed some of these relations, but less often than in French, focusing rather on a very vague kind of attachment (*to fix, to attach*…) or on Path (*into*).

Children's responses showed the following patterns in French (English in progress, see Note 4). First, French children produced responses in which no specific information was expressed (0-responses), particularly with CLOTHES-items (very frequent pattern, e.g. (20)) and to a lesser extent with ONTO-items (less frequent responses, e.g. (21)). Other responses were of two types: X-responses, particularly with INTO-items (very frequent pattern) and to a lesser extent with CLOTHES-items (less frequent responses); (2) V-responses, particularly with FIT-items (very frequent pattern) and to a lesser extent with ONTO-items (less frequent responses). Finally, responses also showed a significant progression with age between three and seven years. The responses of the youngest children often contained a neutral verb with a preposition expressing a resulting location (*mettre dans/sur* 'to put in[to]/on[to]'). With age children increasingly used more specific verbs, either alone (V) or with specific prepositions (VX), resembling more and more the French adults. In addition, children typically focused on manner of attachment or on global configurations, also resembling the French adults in this respect. In summary, the responses of French children showed similarities with those of the French adults, but also showed a notable developmental progression reflecting their increasing mastery of the verbal lexicon that is necessary to use the adult system.

In a second series of studies (Hickmann & Hendriks 2010; Hickmann et al. 2010), subjects had to describe animated cartoons (32 items) that showed a human character (Agent) causing the displacement of an inanimate entity (Object) in the following type of scenario: the Agent walked (Ma) along a certain Path (Pa) while performing an action in a certain Manner (Mc) that Caused (C) the Object to move in a certain Manner (Mo) along a certain Path (Po). The stimuli therefore involved no less than six types of information that were relevant to motion, summarized in (22).[6]

6. Two types of information were constant (C, Mma) while four systematically varied across items (Mc, Pma, Pmo, Mmo). For the purposes of this synthesis, Table 3 groups together all types of Manner (Manner of cause or of motion).

(22) C: Cause – causal relation between Agent and Object (*put*)
Mc: Manner of cause – Agent's action causing O's displacement (*push, pull*)
Pa: Path – Agent (*up, down, across, into*)
Po: Path – Object (*up, down, across, into*)
Mma: Manner of motion – Agent (*walk*)
Mmo: Manner of motion – Object (*roll, slide*)

As illustrated by some adults' responses in (23) to (28), these multiple semantic components could not be expressed all at once within a single proposition. Speakers therefore had to either select some types of information at the expense of others or to find ways of organizing information, for example by means of subordination.

(23) Popi is rolling [C+Mo] the ball down the hill [Po].

(24) He's pulling [C+Mc] a big bag up the roof [Po].

(25) He is sliding [C+Mo] it across [Po] pushing [C+Mc] it to the other side [Po].

(26) *Il pousse* [C+Mc] *le ballon.*
('He is pushing the balloon.')

(27) *Il monte* [C+Po] *le ballon jusqu'en haut* [Po].
('He is ascending[transitive] the balloon to the top.')

(28) *Il traverse* [Pa] *la rue en marchant* [Ma] *et en tirant* [C+Mc] *son cheval de bois*.
('He is crossing the street walking and pulling his wooden horse.')

Table 3 summarizes the results by showing the global semantic density of responses (number of expressed semantic components),[7] as well as the relative frequency with which each type of information was expressed either in the main verb or in other devices (see Note 2). The results show an increase in semantic density with age in both languages, but also a higher density at all ages in English as compared to French. English speakers typically expressed two to three or more components. Responses with three ore more components constituted the predominant pattern among adults and ten-year-olds, and a very frequent pattern among younger children even at four years. In comparison, French responses with three or more components were only predominant among adults and very frequent at ten

7. The number of expressed semantic components varied between none (no component expressed among those shown in (22)) to three and occasionally more (in Table 3 density 3 should read '3 or more').

Table 3. Most frequent patterns in descriptions of animated caused motion events (based on Hickmann & Hendriks 2008; Hickmann et al. 2010)[a]

	Global density[b]	Main verb[c]	Other devices[c, d]
English			
Adults	3***	CM***	P**
10 years	3***	CM***	P**
8 years	3**, 2-, 1-	CM**, oth-	P**
6 years	3**, 2-, 1-	CM**, oth-	P**
5 years	3*, 2*, 1-	CM***, Z-	P***, Z-
4 years	3**, 2-, 1-	CM**, Z-, oth-	P***, Z-
French			
Adults	3***, 2-	CM*, P*, oth-	CM**, P*, Z-, oth-
10 years	3**, 2*, 1-	CM**, P*, oth-	CM*, P*, Z*
8 years	3*, 2*, 1-	CM*, P*, oth-	CM-, P*, Z*
6 years	3-, 2*, 1*	CM*, P*, oth-	P-, Z**
5 years	3-, 2*, 1*	CM**, P*	P*, Z**
4 years	2*, 1*	CM*, P*, oth-	Z***

[a] Relative frequency of response patterns:
*** Predominant = 75% or over
** Very frequent = 50% and over but under 75%
* Less frequent = 25% and over but under 50%
- Infrequent = under 25% excluding responses under 10%

[b] Number of semantic components expressed over the whole response.

[c] P = Path, C = Cause, M = Manner, Z = none (C, M, P not expressed); oth = other cases (e.g. Manner only).

[d] All devices expressing relevant content outside of the main verb and/or in subordinate clauses.

years. Among younger children they were less frequent (eight years), infrequent (five-six years), or practically non-existent (four years). At these ages responses contained as frequently two components (eight years) or one to two components (four to six years). As a result of this language effect, the developmental progression observed in French was much more striking than in English. The responses of French children between three and five years also showed evidence that they encountered some difficulties in expressing multiple types of information, producing for example idiosyncratic expressions in the place of causative constructions (e.g., *enrouler le ballon* Lit. 'to roll [=wrap around] the balloon', instead of *faire rouler le ballon* 'to make the balloon roll').

With respect to content and its locus, although all subjects frequently expressed Cause (central to all items and quasi-obligatory in this situation) and used the main verb to do so, responses clearly differed in other respects. English speakers typically used the main verb to express Cause together with Manner (predominant pattern among adults, very frequent among all children's age

groups). Manner in the verb included Manner of cause (e.g., *push, pull*) and Manner of motion (e.g., transitive *roll*), to which Path was systematically added in other devices outside of the verb (e.g., *push/roll up*, very frequent to predominant pattern across ages). French verbs sometimes expressed Cause and Manner (e.g., *faire rouler* 'to make roll', *pousser* 'to push'). However, at all ages such verbs were less systematic and fluctuated with age (very frequent to less frequent pattern), while other responses were as frequent at all ages, particularly verbs denoting Path alone (e.g. *monter* 'to ascend'). When other devices were used in French, they expressed a variety of components, including Cause+Manner (very frequent among adults, e.g., instrumentals such as *[tirer] avec une corde* '[to pull] with a rope') and Path (less frequent pattern, e.g. *[pousser] jusque dans la grotte* '[to push] all the way in[to] the cave'). However, children often did not use any motion-relevant devices outside of the verb (predominant pattern at four years, very frequent at five-six years, less frequent at eight and ten years). Finally, with increasing age some subordinate clauses encoded additional information (e.g. (25) and (28) above), although these structures were most frequent among adults and more frequent in French than in English. In summary, at all ages, descriptions of caused motion showed again a higher semantic density and more compact structures in English than in French.

2.3 The emergence of spatial language

In order to determine whether such language effects could also be observed among younger children, longitudinal analyses (Hickmann, Hendriks & Champaud 2008) examined the expression of all types of motion events in the early spontaneous productions of four children (two learners of English, two of French) during the emergence of language and early phases thereafter (from 18 months up to about three-four years).[8] We first identified all utterances that contained an explicit motion verb describing any kind of (voluntary or caused) motion, then examined the semantic information that was expressed in each utterance (Cause, Manner, Path) and the means that were used to encode this information, as illustrated below in (29) to (39) for each language (relevant items in bold).

(29) They all **dance**. [V = Manner]

(30) The mouse went **up** the clock. [X = Path]

8. The English data were borrowed from the Childes data base. The corpora in both languages included four developmental periods, showing similar results, except for a notable increase with age of utterances concerning caused motion (in both languages).

(31) You **take** this one. [V = Cause]

(32) See all the cats **swim out**. [VX / V = Manner + X = Path]

(33) I'm going **fly** a kite. [V = Cause + Manner]

(34) I just **pushed** it **down**. [VX / V = Cause + Manner + X = Path]

(35) *Tiens celui-là i **vole**.* [V = Manner]
'Look, this one is flying.'

(36) *Elle **est partie**.* [V = Path]
'She is gone.'

(37) Je le ***mets*** là. [V = Cause]
'I put it there.'

(38) Elle ***rentre à la pointe des pieds***. [VX / V = Path + X = Manner]
'She's entering on her toes.'

(39) *Je **pousse**.* [V = Cause + Manner]
'I'm pushing.'

Table 4 summarizes the main results. They show that children's utterances were again denser in English than in French. Children mostly expressed one component in French (predominant pattern), whereas this pattern was less frequent among English learners who very frequently expressed two components and even sometimes three (although infrequently). French children mainly relied on verbs to express motion-relevant information (predominant pattern), particularly Cause or Path rather than Manner, and they rarely used any other spatial device

Table 4. Most frequent patterns in children's early spontaneous productions about motion (based on Hickmann, Hendriks & Champaud 2008)[a]

	French	**English**
Global density[b]	1***, 2-	1*, 2**, 3-
Locus[c]	V***, VX-	V*, VX**
Content by locus[d]		
Verb	C*, P*, M-	C*, P-, M*
Other	Loc***	Loc*, Path**

[a] Relative frequency of responses:
*** Predominant = 75% or over
** Very frequent = 50% and over but under 75%
* Less frequent = 25% and over but under 50%
- Infrequent = under 25% excluding responses under 10%

[b] Number of semantic components expressed over the whole utterance.

[c] V = verb only, VX = verb + other devices (X = all motion-relevant devices outside of the verb).

[d] C = cause, M = manner, P = path, L = location, Z = none (C, M, P, L not expressed).

outside of the verb. Other devices that did occur consisted of spatial prepositions (*dans* 'in', *sur* 'on') that practically always denoted a general location (predominant pattern). In contrast, English learners typically combined the verb with other devices (very frequent pattern). English verbs expressed Cause or Manner rather than Path, and other devices expressed Path (very frequent pattern) rather than general locations (less frequent pattern).

3. Discussion

This synthesis of several cross-linguistic studies brings together a number of findings concerning how speakers express different types of motion events (voluntary and caused) in a variety of situations (experimentally controlled and natural) at different ages (children aged two to ten years and adults) in languages that present different properties in this domain (English and French). In light of current debates in the field of language acquisition, and notwithstanding common developmental progressions observed in both languages, these results converge in showing the impact of typological variations (satellite- and verb-framing) on the course of first language acquisition.

Our results show important cross-linguistic differences at all ages that follow the particular properties of English and French. First, regardless of age, the semantic density of speakers' utterances varies systematically with their language. In particular, in all situations examined, children explicitly express more information in English than in French. In their descriptions of voluntary motion, English learners use compact constructions expressing both Manner and Path, whereas French learners mainly express either type of information (mostly Path, sometimes Manner), but not both simultaneously except at adult age. Although French adults do produce Manner+Path responses, they do so less frequently than did English learners from six years on. With caused motion, English learners from early on use constructions that jointly express Cause+Manner+Path, while French speakers provide only partial information until a late age and distribute this information in variable ways. Such language differences can be observed in experimental situations with children from three years on and some related differences were also found in early spontaneous productions, such as a higher semantic density from the emergence of language on.

Although these results show the impact of typological properties of linguistic systems on first language acquisition, the density of children's responses also increased with age in both languages, indicating the impact of more general cognitive factors. This second result is not surprising if we simply assume that, regardless of their language, children should find it cognitively easier to express

only one type of information at a time, rather than two or more simultaneously, and/or that they may begin with a cognitive system in which only one piece of information corresponds to a given proposition (see for example Allen et al. 2007). Nonetheless, the striking cross-linguistic differences that were observed at all ages imply that cognitive factors are clearly not sufficient to account for the observed patterns. Recall that cross-linguistic differences were found not only among the youngest children in experimental settings (three years), but also in longitudinal analyses of early spontaneous productions (from emergence on). From very early on, then, children express more information in English than in French. This result suggests that even two-year-olds seem already cognitively able to combine at least two semantic components of motion events from the youngest age onwards, although they do so frequently in English and rarely in French. Finally, differences in density can be related to the particular types of structures that are available in each language. Simple compact structures allowing the joint expression of manner and path are more readily available in English and they are used at all ages. In contrast, French adults resort to complex sentences involving subordination in order to express simultaneously multiple types of information and these structures are not used by younger children.

Complementary production data based on the same methodology support the conclusion that language-specific determinants play a central role in acquisition. Some of this evidence comes from other child languages. Data collected among German children and adults (Ochsenbauer 2010; Ochsenbauer & Hickmann 2010) are very similar to those summarized above for English, confirming the clear status of German as an S-language. A study concerning Chinese (Ji 2009) shows more complex results that raise some questions about the typological status of this language. In particular, children's responses vary as a function of event types, being more like the French pattern with voluntary motion, but more like the English pattern with caused motion. Comparisons across languages also highlight further variations as a function of event types. In this respect, one intriguing result is that young children's productions show different patterns with boundary crossing (ACROSS, INTO) as compared to other types of events (UP, DOWN, TO/TOWARDS), suggesting their greater difficulties in representing these events (although to different extents depending on the language). Thus, with crossing events, young children resort to manner responses or focus on different aspects of path (left and right boundaries, rather than the crossing itself) as compared to older children and adults. Such results deserve some attention in further research, indicating the need for fine-grained studies examining the special status of boundary crossing among motion events.

Further evidence (Hendriks & Hickmann 2010) shows the impact of both source and target language properties among adults learning a second language.

Comparing French and English native adults with English learners of French shows production patterns at early proficiency levels that are highly influenced by English L1, followed by a growing capacity at later levels to overcome structural difficulties resulting from this LI influence. However, notable differences also occur as a function of event types, suggesting that the typological properties of the source language may be more or less constraining depending on the complexity of the task. In particular, learners approximate the target language more quickly when describing voluntary motion as compared to (more complex) caused motion events.

In summary, the evidence supports the conclusion that language-specific factors play an important role during language acquisition, while simultaneously raising new questions that point to further research. The most challenging open question will be to determine the relative weight of cognitive and typological factors on acquisition. Thus, it remains to be determined whether observed cross-linguistic differences in children's productions imply deeper differences in how they process this information beyond language use. According to a strong relativistic hypothesis, languages invite speakers to pay more or less attention to different aspects of their environment, resulting in massive and/or more subtle cross-linguistic differences not only in their linguistic behaviour, but also in their non-linguistic representations in non-verbal tasks.

One promising research direction will be to construct adequate methods to access speakers' internal representations. One such line of research concerns children's co-verbal gestures across languages, as illustrated in a first study (Gullberg, Hendriks & Hickmann 2008) showing that children's gestures are tightly connected to speech and may therefore provide a window onto how they construct representations while planning speech production. Another research direction (Soroli & Hickmann 2010) examines verbal descriptions of motion events with performance in categorization tasks about these events. Adults either saw a target event (video clip) or heard a sentence describing it and were then presented with two videos that differed from the target with respect to either path or manner. Their task was to indicate non-verbally (by pressing a key) which of these two videos looked most like the target video or best corresponded to the target sentence. Preliminary results show that speakers preferentially relied on different categorization criteria, Manner in English and Path in French. Coupling such verbal and non-verbal tasks with an eye-tracking paradigm (e.g. Soroli & Hickmann 2010) also shows that speakers tend to allocate more attention to Path in French and to Manner in English when exploring visual stimuli as they describe motion. A final question to be further examined concerns the earliest age at which language effects might be detected among pre-linguistic infants, especially since previous research shows divergent results in this respect (e.g. Bowerman & Choi 2003;

Hespos & Spelke 2004, 2007). Clearly the so-called 'pre-linguistic' period is far from being non-linguistic and currently constitutes a major challenge for future research as well as a priviledged source of data to confront divergent theoretical views on the relation between human language and cognition.

4. Concluding remarks

Child language data shows that typological constraints play a role in first language acquisition. It further remains to be shown whether the observed cross-linguistic differences merely correspond to superficial variations or whether they actually correspond to 'deeper' differences in how children construct their conceptual representations. It is clear that no all-or-none answer can be provided to this question. It is also clear that addressing this question will require new methods of testing potential language effects on human cognition beyond the use of language itself. Furthermore, given the notorious difficulty in testing such effects, no single method will suffice and a large range of studies will be necessary across disciplines. It is only through multiple approaches and methodologies aiming at capturing verbal and non-verbal representations at different levels of analysis that we will be able to seriously address these questions.

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CHAPTER 8

On the importance of GOALS in child language

Acquisition and impairment data from Hungarian[1]

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Modern psycholinguistic studies started to use experimental and child language observational data concerning the language of space to obtain evidence for the primacy issue: who leads in the articulation of spatial language: language or spatial cognition? Following the model of Landau and Jackendoff, strong claims can be made about the universal distinctions languages make about space and their relationship to the organization of spatial cognition in the brain. However, there are important differences in this regard between languages. Hungarian data will be used to illustrate how a universal cognitive tendency – the primacy of goals – exist very early on in a language that requires distinctions along the path (e.g. *in, into, from inside*). These tendencies are shown both in normal and in developmentally impaired populations.

Our studies on Williams syndrome (in coll. with Á. Lukács) provide some clarifications regarding the language-cognition interface. This condition is characterized by severe limitations of spatial cognition, related to the underdevelopment of posterior parietal areas. In line with these neurocognitive limitations, spatial language in these subjects seems to be very limited as compared to their general level of grammatical morphology. However, detailed comparisons show no differences in the qualitative pattern of performance and errors in using spatial language. It seems that the limitations of computational space limit spatial language in this group, but at the same time the types of computations performed by this limited system are identical. A similar observation also indicates that, in using spatial suffixes to code interpersonal meanings such *as to be angry at*, spatial use is easier and earlier both in normal subjects and in impaired

1. Most of the research reported here was done together with Ágnes Lukács, Ildikó Király and Mihály Racsmány, and the theoretical intepretations were also helped by Ilona Kovács. The studies were supported by OTKA (Hungarian National Science Foundation) grant number TS 049840.

populations. All of these data support a rather universal and cognition-based view of the unfolding and organization of spatial language.

1. Introduction

Following the model of Landau and Jackendoff (1993; Jackendoff 1992; Talmy 2000), strong claims can be made about the universal distinctions languages make about space, and their relationship to the organization of spatial cognition in the brain. As for the linguistic issue, some of these claims relate to the figure-ground like organization of spatial terms, the relevance of PATH organization in articulating the terms. As for the supporting brain organization, the underlying idea is the assumption that the asymmetry between a shape sensitive and abundant nominal system, and a relatively shape insensitive spatial language system (suffixes, adverbials, postpositions and prepositions) would correspond to a division of labor between the ventral WHAT and the dorsal WHERE system in higher visual centers and cortical coding (Ungerleider & Mishkin 1982; Goodale & Milner 1995). These biologically based universalities notwithstanding, there are still important differences in this regard between languages, as emphasized, among others, by Bowerman (1996). Choi and Bowerman (1991) have observed that children acquiring languages where the form of motion is taken into account by choosing word stems, use different attitudes towards dissecting spatial relations such as containment and support, compared to children acquiring so called satelite languages where each spatial distinction is coded by different grammatical morphemes (Bowerman 1996).

In our studies over the last two decades on Hungarian spatial language the basic research issues were driven by the general framework of cognitive theories of spatial markers. We were especially interested in the following issues:

a. What is the difficulty pattern of different roles along the PATH in a language where path distinctions are obligatorily used in spatial coding?
b. What are the acquisition characteristics of spatial case markers and postpositions?
c. Can distinctions and patterns observed in acquisition be revealed in children when they are learning non-existing artificial spatial markers?
d. What happens with spatial language in serious genetic challenges to the spatial orientation system? Do we observe a qualitatively different pattern of spatial language in these cases, like in Williams syndrome?

Hungarian spatial language played an interesting role in the early formation of theories about the relationships of cognition and language. Melania Mikes (1967)

has showed in her studies of Serbian-Hungarian familial bilingual children that the correct use of locative suffixes was observed earlier in the Hungarian than in the Serbian speech of the same children between 2–3 years of age. In the interpretation of Slobin (1973; Johnston & Slobin 1979) this is explained by the fact that in Slavic the child has to co-ordinate two linguistic devices, the preposition and the case marker, while in Hungarian coding is done exclusively at the end of the word by case markers. In Serbian, the difference between 'into the house', i.e. container as goal, and 'in the house' i.e. container as location is between *u kuć-I* and *u kuć-U,* while in Hungarian it is between *ház-BA* and *ház-BAN*. Coordinating two markers separated by the stem seems to be a more demanding task with extra acoustic working memory load. Thus, while the original interpretation of these differences was along the line of there being a linguistic difficulty difference with identical cognitive background provided in the bilingual child speaking either language (Slobin 1973), today we would tend to interpret this very differently.

In a way, the development of spatial language justifies both the driving role of cognition, the crucial role played by perceptual and cognitive development in the unfolding of spatial language, and at the same time what originally seemed to be data on the relative independence of specific linguistic factors, now emerge as modulating more general cognitive factors, such as the use of working memory to integrate linguistic forms. In Hungarian a formally rather homogenous system is used to express cognitively different relations. "Hungarian inflections differ little in terms of formal complexity. Thus, differences in their emergence can be attributed to semantic-pragmatic factors" (MacWhinney 1976: 409). This formal marking difference is an important factor. As Sinha et al. (1994) remark that in their English observational data they were unable to code for GOAL-STATIC differences say in the use of IN. The GOAL over SOURCE difference in most of the languages studied could be due to the greater complexity of expressions.

In the language of space in Hungarian two marking systems are used with noun phrases. Simple types of relations are expressed by agglutinated case suffixes (IN, ON, AT) while postpositions are used to code cognitively more complex relations (UNDER, AMONG, BEHIND etc). This system for each spatial relationship is multiplied by taking into consideration the dynamic aspects of coding of the location and the path. There is a STATIC form for each relationship, and two DYNAMIC forms: one where the coded location, i.e. the reference object (Jackendoff 1994), is the GOAL (the end of the path) and one where it is the SOURCE (the starting point of the path). Multiplied with the CONTAINER, SURFACE and NEIGHBORHOOD relationships, this provides an entirely symmetrical two-dimensional system for spatial case markers, with 9 case markers. Table 1 shows the system for case markers.

Table 1. A summary of the nine spatial case markers in Hungarian

Relationship	Static	Goal	Source
CONTAINMENT (in)	BAN	BA	BÓL
SURFACE (on)	ON	RA	RÓL
NEIGBOURHOOD (by)	NÁL	HOZ	TÓL

For the sake of clarity only the back allomorph of each form is given, while in reality these endings as many others do participate in front-back wovel harmony alternations.

(For a detailed description of the Hungarian language of space see Király, Pléh & Racsmány 2001; Lukács 2005). Our studies on Hungarian first tried to support some general tendencies in spontaneous usage about the primacy of certain relationships and the preference for GOALS.

2. Preference for GOALS in earliest usage

Pléh, Vinkler and Kálmán (1997; see also Pléh 1998) analyzed usage of spatial expressions at the earliest stages of language acquisition, especially with regard to CONTAINER-SURFACE differences, and the importance of directionality. Observational data taken from MacWhinney (1995) were analysed, with 612 spatial suffixes between 1;8 and 2;4 in 5 children. Table 2 shows the distribution of all spatial case markers in percentages, in spontaneous production.

Both locative relation type and directionality had a significant effect. There was a clear preference for CONTAINER relationships, in line with experimental data obtained by Clark (1973) as well as Johnston and Slobin (1979). Regarding directionality, 80% of all markings were GOAL, 13% being STATIC and 7% only SOURCE. Thus, the main effect of directionality basically shows an overwhelming preference for coding the GOALS of intentional action. In Hungarian all these markers are of similar linguistic complexity, and are already in the active repertoire of the children very early on. Landau and Zukowski (2003) as well as Lakusta and Landau (2005) observed similar effects of the difficulty of SOURCE in English,

Table 2. Distribution of spatial case markers in the early speech of Hungarian children between 1;5 and 2;4 (absolute occurrences and percentages)

Relationship	Static	Goal	Source	All
IN	39 (9.4%)	355 (86%)	19 (4.6%)	413 (68%)
ON	27 (22.7%)	86 (72.3%)	6 (5%)	119 (19%)
BY	11 (13.8%)	48 (60%)	21 (26.3%)	80 (13%)
Total	77 (12.6%)	489 (79.9%)	46 (7.5%)	612

and they emphasized that this difficulty might be related to the constraints imposed by spatial working memory.

3. GOAL preference in learning artificial spatial markers

It is a severe limitation of studies based on preferential usage in children that the results might reflect statistical patterns of adult usage instead of the manifestation of a cognitive principle. Thus, the early usage pattern may reflect statistical biases based on adult usage rather than an early cognitive preference on the part of the child. Therefore, along the lines initiated by Landau (1994), we studied learning of artificial spatial expressions that follow the real morphological patterns of Hungarian spatial expressions. If one could show directional GOAL preference even in learning artificial spatial expressions, it would provide strong support for GOAL preference being a general cognitive bias in the spatial coding system. Three related studies were performed where children between 3;6 and 5;6 were presented arrangements like the ones shown in Figure 1, and they were exposed to sentences describing the relationship of the goal object to the reference object in one of three forms.

Our subjects were taught new spatial expressions. In each condition we introduced three different spatial relations as indicated on Figure 1. The child was first familarized with a new nonsense name for the small target object. After familiarization trials with the target objet and its name, the child was presented three times with the target in a given relationship to three different reference objects, accompanied with a nonsense (new) spatial marker presented in a sentence context by the experimenter like (1) to (3) below. Nonsense nouns and relationship markers are indicated by bold in the English glosses.

(1) *The **zuvu** is the booklet-**per**.* Suffix meaning 'under'

(2) *The **zuvu** is the booklet **veker**-én.* Part name meaning 'under'

(3) *The **zuvu** is the booklet **gán**-ott.* Postposition meaning 'under'

After presenting the target relation three times, binary choice situations were created with two reference objects and two target objects being in the required relation and the other in a slightly different one. In the case marker condition three new suffixes were used, each one following the vowel harmony pattern to clearly indicate that these were suffixes. *par/per,* coding the relation 'under'; *kam/kem,* coding the relation 'diagonal', *bat/bet,* coding the relation 'vertical'.

The difference between the three types of (partly) new, partly nonsense markers followed the grammatical structure of Hungarian space-marking. The case

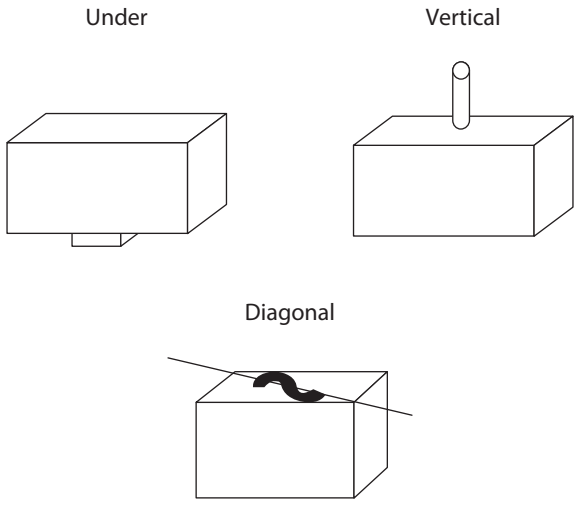


Figure 1. Typical arrangements used in the artificial spatial marker paradigm

markers were artificial, new suffix ending (*doboz-par, füzet-per* 'box-SUFFIX', 'booklet-SUFFIX'). However, with the different reference objects they were used following vowel harmony. That indicated for the child that the nonsense ending is a suffix. Part names are also very frequent in Hungarian, they are used in suffixed constructions also following the path distinction like 'top-on, top-onto' etc.). The artificial part names had a new nonsense stem word with a proper, existing spatial case ending like *a doboz veker-én* 'On-NONSENSE of the box'. Finally postpositions were used where the nonsense stem of the postposition was combined with a typical postposition ending to indicate for the child that the word is a space coding device; e.g. *a doboz gán-ott* 'the box NONSENSE-on', where the *vowel-tt* combination marks a static postposition.

On the whole, the acquisition of case markers appeared to be easier than the acquisition of part-names and postpositions for Hungarian children. In three age groups between 3 and 6 the mean percentages of correct identification of the spatial relationship were 62% for case markers, 52% for part names, and 48% for postpositions. That suggests that acquiring a strongly case marking language, children show a special attention to word endings and therefore case markers continue to be easier learned even after the acquisition of the case system is basically finished (Király, Pléh & Racsmány 2001).

Regarding spatial relations, vertical was the easiest to learn, and diagonal was practically impossible to learn. The most interesting results for the present discussion relate to static and goal differences are shown in Figure 2.

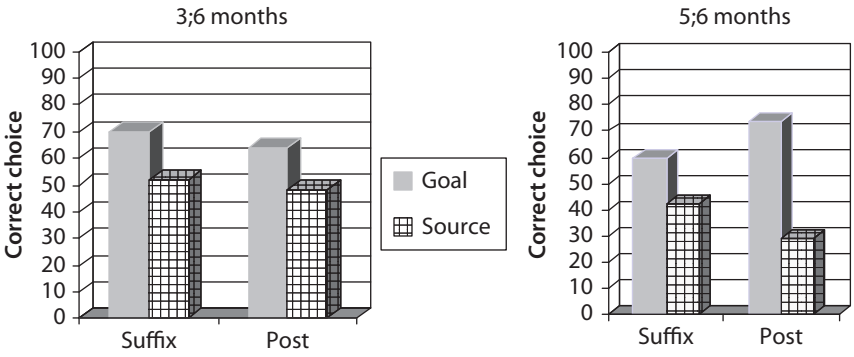


Figure 2. GOAL preference is obtained in artificial spatial markers as well

In this study, only case markers and postpositions were used. However, the experimental setting was varied. Children either had to attend to goal coding situation where the experimenter was putting the target object to a given spatial situation, or to source situations where children had to observe the experimenter taking the target object away form a given position. After the learning trials children here had to perform the given goal or source related action themselves. The fact that the acquisition of goal forms in each condition proved to be the easiest supports that GOAL dominance in spontaneous speech is not merely a reflection of adult usage, but mirrors cognitive preferences on the part of the child as well. Since in our study spatial case markers and postpositions, like real Hungarian expressions, were all simple in their forms and there was no frequency-effect, our results allow us to postulate that the goal directedness of human cognition is an important cognitive bootstrapping factor driving the acquisition of spatial language (Racsmány, Lukács, Pléh & Király 2001). Several studies on younger children and in other languages observed the same effect (Lakusta & Landau 2005 and Lakusta et al. 2007 on infants; Regier & Zeng 2007 on adults speaking Arabic, Chinese, and English).

4. Spatial language in a spatially challenged population: Williams syndrome

In our studies on Williams syndrome in collaboration with Ágnes Lukács, some clarifications regarding the language-cognition interface were made. This syndrome is characterized by severe limitations of visual spatial cognition (O'Hearn et al. 2009) related to the underdevelopment of posterior parietal areas (see on the profile in this respect Bellugi, Lichtenberger, Jones & Lai 2000; Farran & Jarrold

2003, and on the parietal damage, Reiss et al. 2004; Eckert et al. 2005). In line with the neurocognitive limitations, spatial language use in these subjects seems to be very limited compared to their general level of grammatical morphology (see below). Landau and Zukowski (2003) and Landau and Hoffman (2005) showed similar impairments of spatial language in Williams syndrome in English speaking subjects. However, in detailed comparisons of spatial markers elicited by visual displays no differences were found in the qualitative pattern of performance. For example, case markers were easier than postpositions, the same way as in typically developing children, and Williams syndrome subjects also showed a strong goal preference, and specific difficulties with sources (Lukács 2005). It seems to be that the limitations of spatial cognition limit spatial language use in this group, but at the same time the types of computations performed by the limited system, as observed in spatial language use, are identical with the pattern observed in typical development, that raises issues discussed in the literature on developmental impairments regarding what is qualitative difference in development and what is 'merely' slow-down (see Karmiloff-Smith & Thomas 2003).

In our studies we usually tested 15–20 Williams syndrome participants between the ages of 6 and 20 years. (For a detailed description of the sample see Lukács 2005.) As verbal controls, subjects matched on the Hungarian version of the Peabody Picture Vocabulary Test were tested, along with other controls matched for age, and for spatial abilities, the letter one being based on the Cubes subtest of the Wechlsler Intelligence Scale for Children. As Figure 3 shows, along the data from the literature (Farran & Jarrold 2003) our Williams syndrome subjects also showed severe limitations of spatial working memory while their verbal memory was relatively intact (Racsmány et al. 2001). Williams syndrome subjects

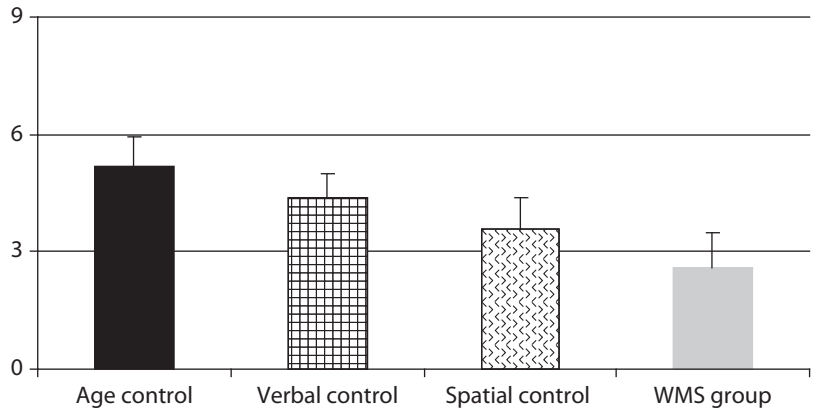


Figure 3. Spatial working memory span in Williams syndrome and different control subjects – Corsi span

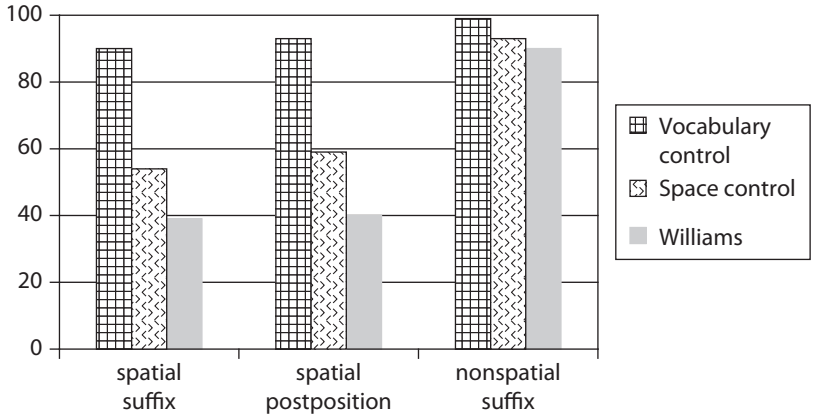


Figure 4. Limitations of Williams syndrome subjects in their spatial morphology as compared to other morphological productions

showed a lower visual working memory span compared to all the control groups except the visual control group. However, while the mean age of Williams syndrome subjects was 12 years at the time of testing, that of the visual control group was 3;6. In general, in accordance with data from the literature, Williams syndrome subjects had a relatively intact acoustic working memory, their digit span being comparable to their vocabulary level controls (Racsmány et al. 2001).

Along with other researchers we also wanted to see the patterning of spatial language in relation to the cognitive limitations in Williams syndrome. As summarized in Figure 4, their overall correct performance in spatial morphology elicited production (case markers and postpositions) was much weaker then in non-spatial morphology such as plurals and accusatives in an elicited production task where subjects had to finish sentences with nouns in the appropriate inflection form, like nominative plural, or singular accusative, the mean correct performance for grammatical morphology being 87%, while for spatial case markers 46, for postpositions 49% (Racsmány et al. 2001; Lukács, Pléh & Racsmány 2004).

Regarding the path distinctions within spatial markers, people with Williams syndrome had an especially hard time with SOURCES, as Figure 5 shows (Pléh, Lukács & Racsmány 2002; Lukács 2005). However, SOURCES were most difficult for the vocabulary control groups as well.

These data support Landau and Zukowski's (2003) hypothesis: the difficulty with retaining information in memory can account for special difficulty with SOURCE in Williams syndrome. But as Lakusta and Landau (2005) show this is true of younger typically developing English speaking children. The same holds for the Hungarian data: the difficulty pattern is similar to what we observe in

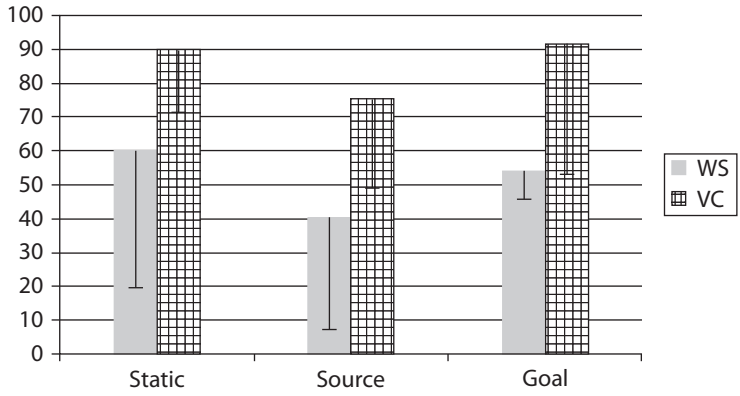


Figure 5. Sources are extremely difficult for Williams syndrome subjects in postposition production

typical development at earlier stages. Interestingly enough, as Racsmány et al. (2001) showed, the correct use of spatial suffixes is related to individual differences in working memory. The overall model of multiple regression with spatial suffixes as the dependent variable had a significant model. $F = 48, 66$, $p < 0.001$, $R^2 = 0.93$). The two predictor variables both had a significant effect: Corsi blocks (visual working memory) 1.62; $p < 0.001$; Digit span (verbal working memory) 0.78; $p < 0.02$.

Thus, the correct use of spatial suffixes in Williams syndrome subjects depends both on spatial and on verbal working memory, but the spatial component is stronger. To further test the nature of impairment in spatial language in Williams syndrome, a sentence completion task was designed to compare the use of spatial suffixes in their spatial and in an abstract or mental sense.

To take some examples, look at sentences (4) and (5) below.

(4) *Pisti tanult a baleset**ből***
'Pisti learnt the accident-FROM.'
Pisti learnt from the accident.

(5) *Az oroszlán megszökött a ketrec**ből**.*
'The lion escaped the cage-FROM.'
The lion escaped from the cage.

While in sentence (4), the suffix is selected for by the verb, in sentence (5) the verb *megszökik* 'escape' only requires that the noun has a SOURCE-type suffix. This information combines with the specifications by the noun *ketrec* 'cage' which is a container, unambiguously specifying the elative as the right suffix choice.

Hypothetically, individuals with Williams syndrome might have difficulties choosing the right suffix with both spatial and nonspatial meanings. Errors with spatial use might arise stemming from the visuo-spatial deficit, although we do not know how much speakers rely on spatial representations when they use spatial terms in the language without direct reference to a present real-world spatial arrangement, e.g. in saying a sentence such as *The lion escaped from the cage* in answer to a question like *What made the director of the Zoo so nervous?*. We would also expect errors with spatial uses if there is indeed a selective deficit of spatial terms *within* language. On the other hand, the concrete – abstract or metaphoric sequence might be true for all speakers, independently of their spatial handicap.

The design of the task also has the potential to teach us something about the language-cognition interface. Cognitive linguists argue that the semantic understanding of language is achieved through the activation of nonlinguistic cognitive models (Talmy 2000), which in the case of spatial terms means activating spatial mental models. There is a possibility that these spatial models are activated during metaphorical use of spatial terms as well, or they might only invoked in understanding concrete spatial terms.

In this study (Lukács, Pléh & Racsmány 2007) subjects listened to sentences without any pictorial support. The sentences always had the last word with a suffix missing (the experimenter pronouncing the stem), and the task of the subject was to complete the sentence. The sentences were requiring the suffixes either in their literal, spatial meaning, or in their abstract, mental meaning, such as (5) and (4). As Figure 6 shows the pattern was strikingly similar for both groups. Spatial meanings were easier than non-spatial meaning. The overall effect of GROUP did

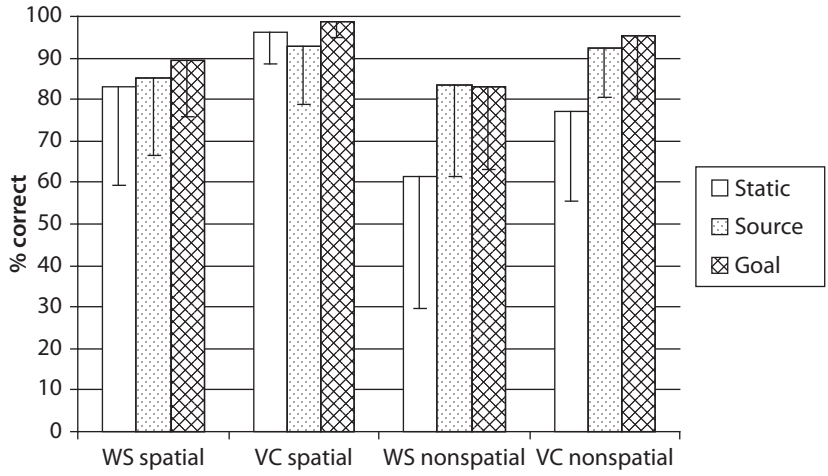


Figure 6. Performance of the WS and VC groups on the task by PATH TYPE

not reach significance ($F(1, 28) = 3.6$, $p = 0.07$). SUFFIX MEANING had a significant main effect; both groups obtained higher scores for sentences with spatial meanings than for sentences with non-spatial meanings ($F(1, 28) = 25.3$, $p < 0.001$). The overall effect of PATH TYPE was also significant ($F(2, 56) = 32.4$, $p < 0.001$), with an interaction between SUFFIX MEANING and PATH TYPE ($F(2, 56) = 16.5$, $p < 0.001$), For both groups, there were no PATH related differences in sentence completion of spatial terms. However, with the mental use, statics were the most difficult ones. We should not forget in interpreting these results that in this task the subjects had to perform an entirely linguistic task (sentence completion) that does not necessarily entail activation of spatial representations.

The results imply that when spatial language is not prompted by the need to describe spatial relations in a scene, WS individuals' special difficulty with spatial language evaporates, and, in fact, with the very same suffixes their performance is better in spatial use as compare to nonspatial use. Thus, their problems in elicited production of spatial terms might be related to their limitations in dealing with the actual physical spatial relation in a scene. Hence, the severe spatial impairment in Williams syndrome does not interfere with language in itself, and does not lead to a selective impairment of spatial terms *within* language, but relates to the language-cognition interface.

5. Conclusion

In general, according to our data, spatial language production is seriously impaired in Williams syndrome, but its pattern is the same as in typical development: the same things are easy and difficult for the Williams syndrome subjects as for typically developing people. No qualitative differences were found between typical and atypical development. It is 'only' the computational space available for the reference of spatial computations that is limited and that strictly limits spatial language use, but spatial language *per se* is not impaired. Difficulties in spatial language thus mirror impairments of spatial cognition, where the crucial mediating variable is limited spatial working memory. Both in typical development and in impaired populations, our data therefore support the effect of universal cognitive factors on the unfolding and organization of spatial language.

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CHAPTER 9

Promoting patients in narrative discourse

A developmental perspective

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Languages provide speakers with a number of structural options for manipulating the expression of events in narrative discourse. Underlying narrative competence is the capacity to view events as dynamic actions composed of a bundle of elements such as, agent, patient, affectedness, etc. (Hopper & Thompson 1980). This study examines the grammatical constructions used by children (5–6, 7–8 and 10–11-year-olds) and adult speakers of Amharic, English, French and Hungarian to manipulate the expression of agent and patient participants in the linguistic formulation of events. The narrative task used to elicit the data is composed of a series of pictures which recount the adventures of two principal characters (a boy and a dog) in search of their runaway frog (*Frog, Where are you?* Mayer 1969). Over the course of the story the boy and the dog encounter a host of secondary characters (a gopher, an owl, a swarm of bees and a deer) and change participant status, going from controlling agent to affected patient of a secondary character's action. Our interest lies in the structures available in the languages studied and their use by children and adults in narrative discourse. We detail how children and adult native speakers of the four languages use topicalising constructions to promote the patient participant in an event to the "starting point" (Langacker 1998) of the recounting of that event.

1. Introduction

Narratives produced by children in monologue and in conversational interaction share most of the same linguistic resources. Producing in a monologue situation, however, requires the ability to access lexical items, to combine propositions, to monitor referential continuity and to assure overall text coherence which requires quick, automatic processing of those linguistic resources without

scaffolding from a conversational partner (Givón 1995; Levelt 1989). In addition, individual messages must be elaborated into a propositional format and transformed into linear form for articulation. The resulting propositions must then be packaged together through the use of various syntactic means available for clause-combining in a particular language.

Our developmental analysis includes four languages – Amharic, English, French and Hungarian.[1] Across these typologically different languages, we will examine the syntactic constructions used to manipulate agent and patient participants in prototypical transitive events (Slobin 1996). As many authors have pointed out, a function-blind crosslinguistic comparison is unworkable (Croft & Cruse 2004; Givón 1995; Hickmann 2003; Langacker 1998). Our analysis compares formal options – word order and voice alternations – when they serve the same discourse function – the topicalization of a patient participant in an event.

In the expression of a transitive event, the patient most often takes the direct object position, as in *John hit Peter*. Given a particular discourse context, however, a speaker may want to topicalize the patient of a transitive event, as in *Peter was hit by John*. English, as illustrated, can use a passive construction in order to topicalize a patient participant, but there are other possible constructions, e.g., focalisation constructions such as *It was Peter that John hit*, (*As for) Peter, John hit him* (Keenan & Dryer 2006; Klaiman 1991; Lambrecht 1994; Myhill 1997; Van Valin & LaPolla 1997). The same conceptual content of an event can be expressed by a variety of structural configurations. There is no single way to verbalize the contents of any given situation in the world – languages provide speakers with a range of structural options for describing the same scene (Berman & Slobin 1994: 516–517; Jisa, Reilly, Verheoven, Baruch & Rosado 2002; Slobin 1996, 2001). In the cross-linguistic developmental work presented here we will examine the structures used by narrators of different ages and different languages to topicalize the patient of a transitive event.

We will begin our investigation with a discussion of event construal or how a given event can be encoded from different perspectives. We will then describe a key component of event construal, the selection of a topic. We then move on to a description of the structures for topicalization of patient participants in the different languages. Subsequently we present the participants and the methodology used in our study. After the section devoted to our results we will conclude by arguing that despite different formal alternatives for topicalizing patients, the developmental trends are remarkably similar.

1. We are very grateful to Ruth Berman and Judy Reilly for having supplied us with the English texts and to Sophie Kern for some of the French texts. We also express our thanks to the *Centre Français des Études Éthiopiennes* for partial financing of the data collection for Amharic.

2. Event construal: Topics, agency and event view

Berman and Slobin (1994) have written extensively on the dimensions relevant to capturing event construal in narrative discourse. These dimensions include selecting a topic, selecting a degree of agency and selecting an event view (Berman & Slobin 1994: 517). Topic is perhaps one of the oldest and most discussed notions in modern linguistics (cf., Lambrecht 1994 for a review). A given referent can be interpreted as the topic of a proposition if the proposition is construed as being about this referent (Lambrecht 1994: 131). Langacker (1998) shows how a "starting point" or a topic serves as the foundation or the base which guides the interpretation of the subsequent information.

In English the sentence topic is most often the grammatical subject (Givón 1995) and the grammatical subject is the first argument in the clause. The functional motivation of structures such as passives (1a), cleft constructions (1b) and dislocations (1c) is to move a non agentive participant into subject/topic position (Keenan & Dryer 2006).

(1) a. Paul was chased by John.
b. It's Paul that John chased.
c. (As for) Paul, John chased him.

Tomlin (1995) proposes that the pragmatic notion of clause-level topic should be understood as the linguistic reflection of a more general process of attention detection. As an event is conceptualized, one event component will be selected and serve as the foundation, or starting point, for verbal expression. Many years ago MacWhinney (1977), using a wide variety of experimental contexts (ie., elicited production, recall, problem solving, sentence verification), was able to show that English speakers use the first element in a sentence as the starting point for the organisation of the sentence as a whole. Following Gernsbacher & Hargreaves' (1992) "structure building framework", the initial sentential elements are privileged in memory and play a crucial role in the building of a coherent mental representation.

The event view dimension of event construal sets the point of view adopted by the narrator (Berman & Slobin 1994: 516). In a prototypical transitive event the agent is the participant who acts with the intention of causing a change of state in the patient (Van Valin & LaPolla 1997). These participant roles can be mapped onto constituents in various ways, depending upon the event view adopted by the narrator and the degree of agency that the narrator attributes to the agent.

A *cause view* represents an event as having an agent that causes a change of state in a patient. Such a view can be illustrated by the transitive construction, *John chased Paul*. In this case *John* is high in agency. There are, however,

constructions which can downgrade the degree of agency of *John* by demoting him to an oblique constituent, such as the agent of a passive construction, *Paul was chased by John*. *John* can be demoted to an even lower degree of agency through encoding him as an oblique source of the action, *Paul ran away from John* (Croft 1991). In this last case *John* may or may not be construed as the external cause of *Paul*'s action. An agentless passive construction, *Paul was chased*, leaves an agent highly implied despite the fact that he is not explicitly mentioned.

Both the notions of topic and event view are key concepts upon which our analysis of event construal is based. We isolate the events in which the patient of an event is selected as topic and the cause view is selected as the event view.

3. Topics in discourse development

Research in narrative development has shown that 5- and 7-year-old children rely heavily on a "thematic subject strategy" (Hickmann 2003; Karmiloff-Smith 1981, 1986), which means that they construe narrative events with the primary character as topic and subject, controlling the activity encoded by the predicate. Consider, for example, one of the episodes in the frog story in which a primary character, the dog, runs because he is being chased by a secondary character, a swarm of bees. Typical of a young narrator is to render this event using an intransitive construction, such as *the dog runs*, in which only the activity of the primary character [the dog] is mentioned. No mention is made of the bees as playing an instigating role controlling the dog's activity (Jisa & Kern 1994). With development children gain the ability to place secondary characters in subject position and to assign to a secondary character a causing or a controlling role in the actions of the primary character (Karmiloff-Smith 1981). This development could favour transitive constructions such as *the bees chased the dog*, in which the primary character is expressed as the undergoer or patient of the secondary character's action. A particularly handy solution to maintaining the primary character as topic and at the same time expressing his status as patient of the activity is a passive construction, as in *the little dog is chased by a swarm of bees*.

The acquisition of passive constructions has received considerable attention in the literature on the acquisition of grammatical competence and verb selection has been shown to be an important aspect of passive acquisition. Prototypical transitive verbs with animate agent and patient arguments, and which encode events resulting in a clear change of state are prime passive attracting predicate types (Bowerman 1982, 1983).

Other developmental studies on the passive have attempted to capture the discourse contexts in which children actually use passives (Berman 1994;

Bowerman 1982, 1983; Demuth 1989; Marchman, Bates, Burkardt & Good 1991; Slobin 1993). Marchman et al. (1991) show how discourse context is instrumental in triggering passives. After viewing a video composed of a number of scenes, children were asked to tell something about the scenes. The elicitation procedures varied: the children were asked questions which established as topic either the agent (i.e., *what did the dog do?*) or the patient (i.e., *what happened to the cat?*). The children's ability to use the passive to report on the scenes from the perspective of the patient increased with age and was directly related to the question.

Marchman et al. (1991) were also able to show that young English-speaking children (3- to 7-year-olds) used alternate structures to topicalize the patient in just those contexts where older children and adults used passive constructions. The authors argue that such use reveals sensitivity to the discourse requirements. For instance, verb selection succeeds in doing much of the work of the passive construction (e.g., *the girl got/received the flowers from the man*). Other structures include two clause constructions (e.g., *the tiger is just sitting there and the bear licks him*) and cleft constructions (e.g., *it was the tiger that the bear licked*). Part of achieving end-state adult control of the use of passives depends, then, upon building a strong association between the passive construction and the particular discourse contexts which attract it.

In our study of children and adults we adopt a cross-linguistic perspective on this issue by comparing how speakers encode events using passives and dislocations – constructions which share a common functional domain in that they can be used to assign a clausal-topic function to a non-agentive argument. In the following section brief sketches of the constructions used for topicalizing patient participants in the four languages will be presented. However, before turning to these brief sketches, two typological factors, word order and obligatory subjects, should be commented.

4. Word order and obligatory subjects

French and English are relatively rigid SVO languages. Amharic is an SOV language. Hungarian is often considered SVO, however, word order in Hungarian is perhaps better described as Topic (focus) Verb (X) (Kiss 2003). Direct objects in English and French are indicated by word order. The two languages differ in that in French, the object clitic occurs in a preverbal position. In English when the direct object is pronominalized, it remains in post verbal position. In Amharic and Hungarian direct objects are marked with an accusative suffix. In addition, transitive verbs in Amharic take an object agreement suffix, as illustrated in (2).

Notice also that the verb in Amharic agrees in number and gender with both the subject and the object.[2]

(2) *Afɨnčʼa-wɨ-n* *bwaččʼər-əčči-w*
nose-POSS.3M-ACC scratch-PERF.3F-O.3M[3]
'His nose, she scratched it.' (7-year-old)

In Hungarian, transitive verbs have two possible conjugations. If the third person direct object is definite, the "objective" conjugation is used; if it is indefinite (or if the verb is intransitive) the "subjective" conjugation is used (Kenesei, Vago & Fenyvesi 1998), as illustrated in (3).

(3) *A fiú meg-zavar-ja a bagly-ot, aki*
DEF boy PV-bother-PRES.3SG.OB DEF owl-ACC REL
meg-zavar egy méh-kas-t
PV-bother.PRES.3SG.SU INDEF bee-hive-ACC
'The boy disturbs the owl who disturbs a bee-hive.' (7-year-old)

Amharic and Hungarian are non-obligatory subject languages, given that the subject is indexed on the verb, whereas English and French are obligatory subject languages, requiring a pronoun or a clitic before the verb.

5. Constructions for topicalizing patients

Three of the four languages – Amharic, English, and French – have productive passive constructions. Amharic has a morphological passive (4a), whereas English (4b) and French (4c) have analytic periphrastic passives with an auxiliary.

(4) a. *kä-gudgwad west leJ-u bä andit ensäsa ye-mmätt-al*
from-hole in boy-DEF by an animal 3M-PAS.IMPERF.hit-AUX
'from the hole the boy is hit by an animal' (adult)
b. *Now the boy has been picked up by some antlered beast*. (adult)
c. *Le chien est donc poursuivi par les abeilles*. (adult)
'The dog was thus followed by the bees.' (adult)

In Amharic the agentless passive is by far the most frequent, particularly when the agent is animate. For English and French the agent can also be left unmentioned.

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2. Whenever possible we will use examples from the frog story texts.

3. The orthographic conventions for Amharic follow Amberber (2002). A list of abbreviations is given in Appendix 1.

English and French have additional constructions for promoting the patient to the topic position: the *get*-passive (5a) and the reflexive middle (5b) (Jones 1996). In French this construction is formed by using *se* and the causative marker, *faire*. A functionally similar construction employing the causative and the reflexive is observed in Amharic (5c). In Hungarian (5d) a similar structure employs causative morphology on the verb with the "agent" of the action being downgraded to an instrumental, indicating that the agent's action was the means by which the patient was affected.

(5) a. *The boy got chased by the owl.* (5-year-old)
b. *Pendant que le chien se fait poursuivre*
'While DEF dog REFL.3SG CAUS.PRES.3SG pursue-INF
par les abeilles.
by DEF bees
'While the dog got himself pursued by the bees.' (Adult, 20)
c. *leJ-u tä-s-fänTer-o*
child-DET.M REFL.-throw-GER.3P.MS
'The boy being/getting himself thrown.' (Mehden, 25)
d. *A fiú meg-harap-tat-ja magá-t a vakond-dal*
DEF boy PV-bite-CAUS-PRES.3SGOB REFL.3SG-ACC DEF gopher-INST
'The boy made himself get bitten by/with the mole.' (invented example)

In these English and French examples *the boy* is construed of as being the patient, although he may have had a role in causing the mole to want to bite him. In the Hungarian example, *the boy* is construed of as the agent which has considerable control over the event. No instances of this Hungarian construction were observed in our texts.

A Hungarian construction which is subject to considerable controversy is sometimes referred to as a resultative passive. Its status as a passive construction is called into question in traditional Hungarian grammars (Tompa 1961; Rácz 1968) which view it as a participial construction involving the copula and expressing a state adverbial (Kenesei et al. 1998: 282–283). This Hungarian construction employs the copula which is marked for tense, person and number. The lexical verb is in the adverbial participial form, bearing the *-va*/*ve* suffix ("simple converb", Kenesei et al. 1998).

(6) *A ház el lett ad-va*
DEF house PV be.PAST.3SG give-va
'The house has been sold.'

There is an archaic passive form (-(*t*)*at*, (*t*)*et*), illustrated in (7) but in contemporary Hungarian this form is no longer used.

(7) *A ház el-ad-at-ik*
DEF house PV-give-PAS-PRES.3SG
'The house is sold.'

The four languages also use object dislocation constructions for topicalising the patient participant in an event. In dislocations, the direct object is put in initial clause position, leaving a mark at the site of extraction. The case marking on the dislocated direct object in Amharic (8a) and Hungarian (8b) remains accusative. In Amharic (8a), notice that the verb maintains the object agreement morpheme and the dislocated object is most usually followed by a topic marker, *dämmo* (Demeke & Meyer 2007). In Hungarian (8b) the verb shows the objective conjugation. In French (8c) a clitic trace (*l'*) occurs in the matrix. While such constructions do exist in English no examples were observed in the English data.

(8) a. *wesha-wa-n dämmo neb-occ-u*
dog-DEF.F-ACC top bee-DEF.PL.-DEF
y-abbarrer-u-at-al
3PL.M-IMPERF.pursue-3PL-O3F-AUX
'And the dog, the bees chase her.' (7-year-old)
b. *közben a kutyá-t el-kezd-t-ék kerget-ni*
meanwhile DEF dog-ACC PV-start-PAST-3PL.OB pursue-INF
a darazs-ak
DEF bee-PL
'Meanwhile, the dog, the bees started to pursue him.' (adult)
c. *euh- le garçon- l'hibou l'a poussé contre un:- un rocher,*
eh DEF boy DEF owl ACC AUX push.PP against INDEF bolder
'eh the boy – the owl pushed him against a a bolder.' (10-year-old)

In addition to dislocations of the direct object dislocations of oblique arguments of intransitive verbs were observe in Hungarian (9a) and in French (9b).

(9) a. *és akkor a kutya után repül-t-ek a méh-ek.*
and then DEF dog after fly-PAST-3PL DEF bees-PL
'and then the dog the bees flew after.' (7-year-old)
b. *Le chien les abeilles lui courent après*
DEF dog DEF.PL bees DAT run.3PL after
'The dog the bees run after him.' (7-year-old)

In both of these examples the dog is construed of more as a goal rather than as a patient. We included these constructions because the principal character is placed in first position, focus of attention (MacWhinney 1977).

We want to argue that dislocation constructions give children a developmental advantage for encoding the patient of the event in comparison to passive constructions. Passive constructions change the argument structure of the clause while object dislocations do not. In addition, passive constructions call for modifications of the verb form, while object dislocations do not. In our study we attempt to show that children use object dislocations for topicalising a patient participant earlier than they use passive constructions. Thus, Amharic- and French-speaking children should use dislocation structures before using passives. Hungarian-speakers have access only to dislocation structures and they should use them before the other children use passives. English-speakers have access only to passive constructions and their use should be observed after the use of dislocation constructions in the other languages.

After examining the uses of passive and dislocation structures individually we will combine them together as a set of topicalisation structures. We again hope to show that dislocation constructions yield a developmental advantage in the sense that we are expecting Amharic, French and Hungarian children to topicalise the patient of a transitive event before English-speaking children use passive constructions. For the adult groups we are not expecting any difference between languages in the amount of topicalisation structures used.

6. Methodology

6.1 *The Frog Story*

The narratives used for this study were elicited from 5-, 7- and 10-year-olds and adult monolingual speakers of Amharic, English, French and Hungarian, using the picture book task *Frog, where are you*? (Mayer 1969), following the procedures given in Berman and Slobin (1994). For the four languages the children were first shown all the pictures by an adult. Then a second adult comes into the room to serve as an audience for the child's narration. The adults tell the story directly to the first adult after having looked at all the pictures. All of the researchers and the adults who were the audience for the children's stories were native speakers.

The frog story is particularly useful for cross-linguistic investigations as all the narrators are charged with the task of transforming a series of pictures into a coherent story. For some episodes the pictures depict the boy and the dog as agents (the dog chases the deer, the boy finds the frogs) while others show the boy and the dog as patients of the event (the dog is chased by the bees, the boy is bitten

by a gopher). It is these last episodes – where the boy and the dog are patients of the event – that serve as the basis for our comparison of topicalisation structures across languages.

6.2 Coding

All clauses in the stories were coded as (1) Intransitive, including intransitive constructions with or without an oblique argument; (2) Transitive, including both transitive and causative constructions; (3) Dislocation constructions in which the patient participant is in initial position; and (4) Passive, including both passives and the functionally equivalent structures in (5). The native speaker of each language coded each clause individually. The native speakers' codings were then discussed by all authors working in a group. Disagreements were debated upon until agreement. Only the last two categories of constructions – those considered as patient topicalising constructions – will be presented in this analysis. These two categories represent the cases in which the patient of the event (either the boy or the dog) is either in initial subject position or is dislocated to initial position and is construed of as the patient of the action. Table 1 presents the mean total of clauses in the stories for all the languages.

Table 1. Number of subjects, mean number of clauses and range of clauses in the *Frog Story* narratives

		5-year-olds	7-year-olds	11-year-olds	adults
Amharic	*n*	15	15	15	15
Mean clauses per subject		49	55	64	94
Range of clauses		28–91	33–87	15–130	54–130
English	*n*	15	15	15	15
Mean clauses per subject		50	58	72	74
Range of clauses		32–74	13–123	43–98	48–123
French	*n*	20	20	20	20
Mean clauses per subject		56	57	62	80
Range of clauses		15–189	13–189	15–123	46–189
Hungarian	*n*	15	15	15	15
Mean clauses per subject		51	41	55	72
Range of clauses		28–91	13–69	23–106	19–189

7. Results

7.1 Dislocations

Figure 1 shows the distribution of dislocation constructions across languages. No dislocations were observed in the English data. Two one-way ANOVAs reveal a significant effect for LANGUAGE ($F(3,251) = 59.71$, $p < .0001$) and for AGE ($F(3,251) = 2.6$, $p = .04$).

At five years of age LANGUAGE shows a significant effect ($F(3,61) = 12.45$, $p < .0001$). The Amharic five-year-olds use dislocations more that the Hungarian (Fisher, $p = .005$) and the French (Fisher, $p < .0001$) five-year-olds. At seven years of age LANGUAGE continues to show a significant effect ($F(3,61) = 16.43$, $p < .0001$). Fisher tests reveal that French-speakers use fewer dislocation constructions than do Amharic ($p < .001$) and Hungarian ($p < .001$) seven-year-olds. No difference is observed between Amharic and Hungarian at seven years of age. At ten years of age LANGUAGE has a significant effect ($F(3,56) = 27.10$, $p < .0001$). The French ten-year-olds use fewer dislocation constructions than the Amharic ($p < .0001$) and the Hungarian ($p = .0003$) narrators. Fisher tests reveal a significant difference between the Amharic and Hungarian ten-year-olds ($p = .0004$), with the Amharic children using more dislocation constructions. For the adult groups LANGUAGE continues to show a significant effect ($F(3,61) = 19.13$, $p < .0001$). French-speaking adults use fewer dislocations than do the Amharic-speakers ($p < .0001$) and the Hungarian-speakers ($p < .0001$). No significant difference is observed between the Amharic and Hungarian adults.

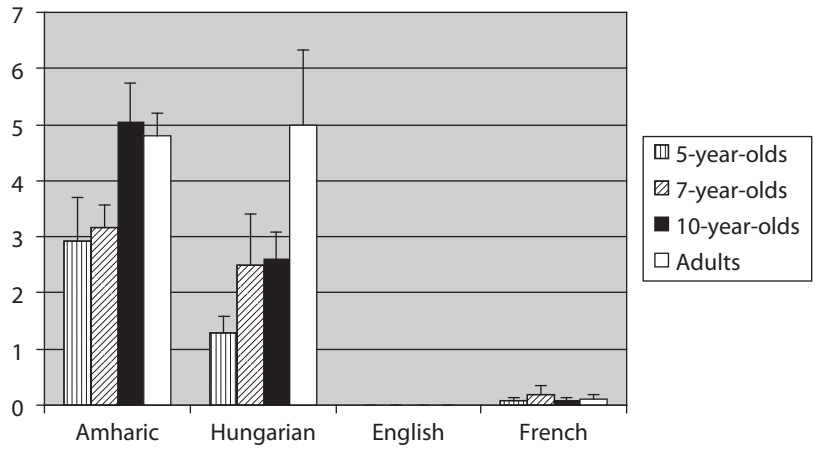


Figure 1. Percentages of dislocation constructions in Amharic, English, French and Hungarian *Frog Stories*

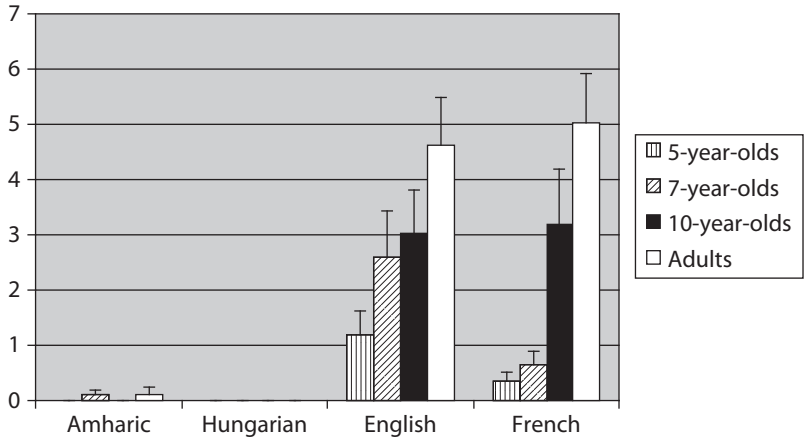


Figure 2. Percentages of passive constructions in Amharic, English, French and Hungarian *Frog Stories*

7.2 Passives

Figure 2 presents the percentage of passive constructions observed across the four languages. As expected no passive constructions were used by the Hungarian narrators. Figure 2 shows the mirror image of Figure 1, with passive constructions observed primarily in English and French. LANGUAGE is a significant factor ($F(3,251) = 24.08$, $p < .001$). Fisher tests reveal that Amharic-speakers use fewer passive constructions than do English- ($p < .001$) and French- ($p < .001$) speakers. No difference is observed between English and French.

At five years of age, LANGUAGE shows a significant effect ($F(3,61) = 6.30$, $p = .0008$). Fisher tests reveal that at five years of age English narrators used significantly more passives than do the Amharic ($p = .0004$) and the French ($p = .005$) narrators. The same pattern is observed at seven years of age: LANGUAGE shows a significant effect ($F(3,61) = 8.25$, $p = .001$) and the English narrators use passive constructions more than do the Amharic ($p < .0001$) and French ($p = .0008$) seven-year-olds. At ten years of age LANGUAGE continues to show a significant effect ($F(3,56) = 7.45$, $p = .0003$) with Amharic differing from English ($p = .001$) and French ($p = .001$). No difference is observed between English and French. The results for the adult speakers are almost identical to those obtained at ten years of age. LANGUAGE is significant ($F(3,61) = 16.17$, $p < .0001$) with the English and French adults using more passive constructions that the Amharic adults.

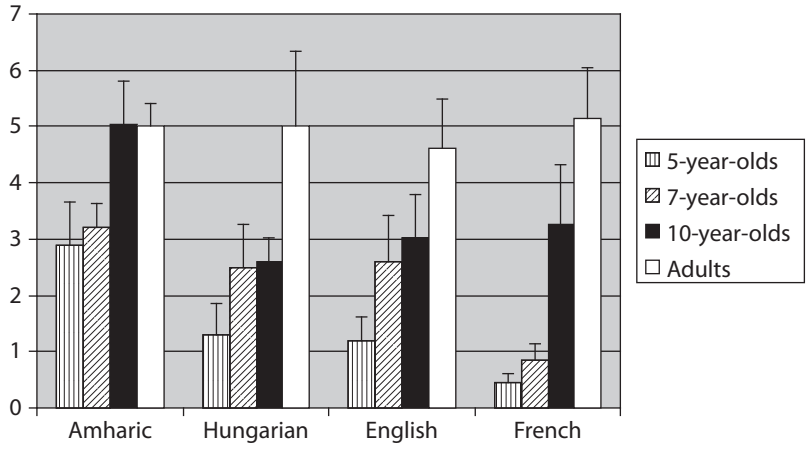


Figure 3. Percentages of topicalisation constructions in Amharic, English, French and Hungarian *Frog Stories*

7.3 Topicalisation constructions

The two forms of topicalisation structures – object dislocation and passive constructions – are combined in Figure 3. A one-way ANOVA reveals that LANGUAGE has a significant effect ($F(3,251) = 3.34$, $p = .01$) with Amharic differing significantly from English ($p = .04$), French ($p = .002$) and Hungarian ($p = .03$). No difference is observed between these last three languages.

At five years of age there is an overall effect of LANGUAGE ($F(3,61) = 5.45$, $p = .002$) with Amharic differing significantly to English ($p = .02$) and French ($p = .0005$), but not to Hungarian. The difference between Hungarian and French is significant ($p = .005$) while the differences observed between Hungarian and English are not. At seven years of age LANGUAGE continues to show a significant effect ($F(3,61)$, $p = .01$) with French seven-year-olds showing fewer topicalisation constructions than do Amharic ($p = .003$), English ($p = .02$) and Hungarian ($p = .02$) children. At ten years of age, no overall effect of LANGUAGE is observed ($F(3,56) = 2.55$, $p = .06$). Finally, for the adult groups no significant difference is attributed to LANGUAGE.

7.4 Summary of the results

The results obtained reflect partially what was expected. The Amharic children used dislocations frequently at age five and before the use of passive constructions, which as it turns out are very infrequent even amongst the adults. Hungarian

speakers used dislocations, the only alternative available to them, before the French speakers. Somewhat disappointing is that the French-speakers used very few dislocations despite the fact that these constructions are available and relatively frequent in spoken French (Berrendonner & Reichler-Béguelin 1997; Gadet 1997). This may be a reflection of the task in that telling the frog story is close to a school situation and children may avoid using constructions that deviate from the written norms. The Hungarian and the English children began using topicalisation structures – object dislocation for Hungarian and passives for English – at roughly the same time.

Figure 3, which combines both dislocations and passives, shows clear developmental curves for all four languages. The 10-year-olds and the adult groups do not differ in the amount of topicalisation constructions used.

8. Conclusion

In this study we attempted a cross-linguistic study of topicalisation constructions used to encode the patient of an event as the "starting point" for formulation. Our results reveal that in all four languages – Amharic, English, French and Hungarian – children begin to use these constructions in narrative discourse at 5 years of age. This finding argues for a common functional source of the use of object dislocation in Amharic and Hungarian and passives in English and French. We hope to have demonstrated that a functional approach to cross-linguistic analysis is essential for understanding how, depending on the language, children use different forms for the same function.

Direct observation of an individual's conceptualisation of an event is impossible. However, much can be learned through examination of how events are construed for formulation. Our study underscores the fact that the understanding of "thinking for speaking" (Slobin 1996) requires consideration of both commonly shared functionally driven motivations, as well as language-specific facts.

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Appendix 1

List of abbreviations

1	first person
3	third person
ACC	accusative
AL	allative
AUX	auxiliary
CAUS	causative
DAT	dative
DEF	definite
DIM	diminuitive
F	feminine
GER	gerund
IMPERF	imperfective
INDEF	indefinite
INF	infinitive
INST	instrumental
M	masculine
OB	objective conjugation
PAS	passive
PAST	past tense
PERF	perfective
PL	plural
POSS	possessive
PP	past participle
PRES	present
PV	preverb
REFL	reflexive
REL	relative
SG	singular
SU	subjective conjugation
TOP	topic

CHAPTER 10

On-line grammaticality judgments

A comparative study of French and Portuguese[1]

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On-line sentence processing in children is still an emerging field. This cross-linguistic study examined the on-line sentence processing in a grammaticality judgment experiment. In each language (French, Portuguese) three age groups of children (6–7 year-olds, 8–9 year-olds and 10–11 year-olds) and a group of adults were asked to detect grammatical violations as quickly as possible. Three factors were studied: the violation position (early vs. late in the sentence), the violation span (intraphrasal vs. interphrasal), and the violation type (agreement vs. word-order). The main developmental results were as follows. Not surprisingly, children of both languages were always slower than adults at detecting grammatical violations. No matter how old they were or which language they spoke, subjects were faster at judging sentences with violations that occurred later and the effect was especially strong in the younger groups. As predicted, intraphrasal violations were more rapidly detected than interphrasal ones in French, but Portuguese subjects presented the opposite pattern. This paradoxical result seems linked to the low perceptibility of phonological violations in oral sentence processing. Finally, agreement violations were more rapidly detected than word-order ones at every age in French, whereas, such differences did not reach significance in Portuguese. Crosslinguistic comparisons between these two romance languages are discussed in the light of cue validity and cue-cost interactions during on-line sentence processing.

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1. Introduction

Since Garrett (1990), it has been acknowledged that data concerning the processing of sentences in normal adults presents different characteristics when gathered during the post-comprehension stage than when gathered in real time. On-line sentence processing by children is still an emerging domain, even if, a long while ago, Tyler and Marslen-Wilson (1981) clearly underlined the theoretical interest of developmental studies in this field. The rarity of these studies is most certainly linked to methodological difficulties as indicated by Kail and Bassano (2003). Nevertheless, the growing importance of on-line methods in child language research is well attested in Sekerina, Fernandez and Clahsen (2008), a volume providing overviews of innovative methods ranging from behavioral (word monitoring, probe recognition, real-time grammaticality judgment) to paradigms involving eye tracking, such as the Visual World paradigm (free-viewing and looking while listening) and event-related potentials. These methods can be used with children from about 5 years of age onwards to study relatively complex syntactic and morphosyntactic phenomena.

In the present chapter our goal is to present monolingual developmental data on the on-line integration of two basic grammatical constraints, word-order configurations and morphological agreements in two Romance languages French and European Portuguese chosen for their pertinent linguistic similarities and contrasts. The main purpose is to identify what on-line processing procedures are affected by the specificities of the language and what procedures seem to be general universal when real-time grammaticality judgments are processed.

Real-time language processing requires the listener or reader to integrate linguistic cues into the ongoing sentence representation. Language is a complex system that involves different types of information (i.e., phonological, syntactic, semantic, morphosyntactic) that must be retrieved and used to achieve comprehension. Different psycholinguistic theories agree that all these information types must be retrieved and used in normal on-line comprehension, but there is still some debate about the timing of information use and the nature of the interplay between syntactic and lexical-semantic information.

In the serial and modular approach, the strongest claims, such as the garden path theory (Frazier 1987) propose that structural syntactic principles – minimal attachment and late closure – are sufficient to explain the first syntactic analysis and the local phrase structure building. For example, according to late closure, the parser prefers to attach locally, low in the syntactic tree. Information from other components, such as semantic and pragmatic ones, may play a role only after the parser has made an initial structural assignment attachment. Altmann (1989) provided evidence to suggest that referential information can influence the

parser's decisions and prevent garden path effects. On the whole, as underlined by Mitchell (1994) much of the work on parsing is based on the notion that human parsing involves building something like 'linguists' tree diagrams.'

From other perspective, the interactive models challenge the idea that syntax occupies a privileged position in the initial parsing of sentences (McClelland, St John & Taraban 1989; MacWhinney 1987; MacWhinney & Bates 1989). According to these models, the parser is immediately able to integrate all available linguistic information. In this single system all cues or constraints guide the construction of a unique representation as a function of their relative weights.

Our framework is the Competition Model (CM) (MacWhinney 1987; MacWhinney & Bates 1989) an integrative-activation model of language comprehension and language use that emphasizes qualitative and quantitative linguistic variations across languages. In this model, the informational value of linguistic forms in a given language plays a probabilistic role in mapping surface forms to their underlying functions as directly as possible. The CM assumes parallel processing, and the language processor can use compound input cues that work across linguistic boundaries, e.g. prosody, morphology, syntax, and semantics. In contrast to modular theories in which different pieces of linguistic information are computed sequentially by separate processor mechanisms, the CM processes information from various sources via a common set of perceptual, representational, and retrieval mechanisms. Different cues cooperate and compete with each other in language comprehension, where coalitions and competitions represent the mediation process between forms and functions. When parallel activation of the formal and functional levels leads to competition, the co-evaluation of different linguistic sources becomes necessary and is directly determined by the validity of these cues in the particular language.

The notion of cue validity is the central predictive construct of the model, representing the informative value of a given source of information (for example, the subject preverbal position in English) for the assignment of a particular function (for example, the semantic function of agent). Cue validity is defined by two properties, availability and reliability. If a cue is there whenever needed, it is high in availability. If a cue is never ambiguous and always leads to the correct interpretation, it is maximally high in reliability. An example of a very valid cue in English is preverbal position of the sentential subject which is both available and reliable for agent assignment, contrary to what happens in Italian, Spanish or Portuguese, romance languages, where there is a more flexible word order. Another fundamental notion is cue strength. Whereas cue validity is an objective property of the stimulus, measured in samples of inputs given to the language learner, cue strength is a subjective property of the language user. According to the processing hypotheses proposed by the model, cue strength depends on cue validity in a

given language. In children, the main hypothesis is that the order in which cues for sentence comprehension emerge in a language is largely a function of the relative validity of cues in that language.

A substantial body of studies (for reviews, see MacWhinney & Bates 1989; Kail 1999; Bates, Devescovi & Wulfeck 2001) conducted over a wide range of languages revealed a strong correlation between cue validity and cue strength in sentence processing. The results also supported the assumption that children acquire sentence comprehension strategies in a sequence that is predictable from cue validity of the grammatical devices in the adult language. The second basic notion that Kail (1989) proposed to implement in the CM is 'cue cost', which refers to the amount and type of processing required for the activation of a given form when cue validity is held constant. In line with an earlier proposal by Ammon and Slobin (1979), it was suggested that cues are distributed along a processing-type continuum that ranges from local (an interpretation can be computed as soon as the cue is encountered) to topological (the interpretation is delayed until all information is stored and compared). In some languages like French (Kail 1989), Italian (Devescovi, D'Amico & Gentile 1999), and German (Lindner 2003), cue validity and cue cost interact during development. Some predictions based on the idea that children acquire sentence-interpretation strategies in an order that can be predicted from cue validity in the adult language have been updated to take into account the greater short-term memory demands of topological processing.

Assuming that cue validity and cue cost interact to determine cross-linguistic variations in the use and development of sentence-interpretation strategies, the investigation of cue cost requires more information about how listeners allocate their attention and make predictions in the course of sentence processing (Kail 1999; Kempe & MacWhinney 1999; Devescovi & D'Amico 2005; Staron, Bokus & Kail 2005).

The research we have undertaken into on-line sentence processing takes as its starting points that the linguistic information processing system is involved in a continual readjustment when assigning syntactic and thematic roles in a sentence. Such a system tends to combine the various sources of linguistic information by conferring meaning as rapidly as possible on the basis of processing cues, integrating linguistic fragments into larger structures that are compatible with the information already processed. This mode of parallel processing optimizes local attachments between units, thus decreasing the cognitive load for the processor.

Some studies conducted with adults had begun to test these hypotheses in various languages: Wulfeck, Bates and Capasso (1991) in English and Italian; Wulfeck (1993) in English; Devescovi, D'Amico and Gentile (1999) in Italian; Li, Bates and MacWhinney (1993) in Chinese; Mimica, Sullivan and Smith (1994) in Serbo-Croatian; Kail and Bassano (1997), Lambert and Kail (2001), Kail (2004a)

in French; Kail and Diakogiorgi (1998) in Greek; Kempe and MacWhinney (1999) in Russian and German; Staron, Bokus and Kail (2005) in Polish; and Costa, Faria and Kail (2004), Costa (2005) in Portuguese.

In the field of on-line sentence processing in children, systematic crosslinguistic comparisons are still extremely rare. However, several recent syntheses in this fast expanding field are now available (Bates, Devescovi & D'Amico 1999; Bates, Devescovi & Wulfeck 2001; Devescovi & D'Amico 2005; Kail 1999; Kempe & MacWhinney 1999). Other studies have approached such processing from the point of view of atypical language development in children with Specific Language Impairment (SLI) (Wulfeck, Bates, Krupta-Kwiatkowski & Saltzman 2004) or children with focal lesions of the brain (MacWhinney, Feldman, Sacco & Valdés-Pérez 2000).

Kail and team have begun to develop an international program involving languages chosen for relevant linguistic contrasts with regard to the specificities of real time processing, viz., French, English, Swedish, Greek, Portuguese and Polish. Among the experimental paradigms used, one of the most productive concerns judgments of grammaticality in real time (Wulfeck 1993; Blackwell & Bates 1995; Blackwell, Bates & Fisher 1996; Kail & Bassano 1997; Kail & Diakogiorgi 1998).

The capacity to make judgments about grammaticality has chiefly been studied from the point of view of the development of metalinguistic skills. The central question in such studies is, when exactly do children become capable of abstracting themselves from the communicative context in order to grasp and manipulate the structural characteristics of the spoken language. The consensus that emerges from studies undertaken in the past (Gombert 1990; Pratt, Tunmer & Bowey 1984; Tunmer & Grieve 1984) indicates a capacity which is really only properly installed by mid-childhood. Apart from this developmental progression, these studies mention that young children are more receptive to the semantic components of utterances and that older children show an increasing awareness of the morphosyntactic constraints of the language they speak. Nevertheless, research on the sensibility to grammatical violations in infants (e.g. Gerken, Landau & Remez 1990) indicates that this is a process going from very early implicit to explicit knowledge of grammatical regularities.

In the present study, we will compare results obtained in French (Kail 2004a) from those obtained in European Portuguese. One important question is to indeed determine whether the typological proximity between these two Romance languages is reflected in their real time processing procedures. For example, we will examine whether the phonetic constraints that affect inflectional agreement morphemes may vary within a single language family by modifying the perceptibility degree of oral language cues.

2. Some properties of European Portuguese and French: Agreement and word-order

Given that a detailed description of the properties of French has already been presented in Kail (2004a), we focus below in more detail on the properties of Portuguese (Mateus et al. 2003) relevant for the present research, i.e. agreement and word order.

Sentence word order
Although the canonical order is SVO for simple transitive declarative sentences in both languages, European Portuguese is a null subject language that allows sentences without a lexicalized subject (1) and declarative sentences with post-verbal subjects (2) to (4):

(1) Escreveu o sumário e saiu.
Wrote the summary and left.

(2) O professor escreveu o sumário (SVO)
The teacher wrote the summary.

(3) Escreveu o sumário o professor (VOS)
Wrote the summary the teacher.

(4) Escreveu o professor o sumário (VSO)
Wrote the teacher the summary.

Nominal phrase word order
Although definite articles are placed before the noun in both languages, there are differences in the positioning of other elements. In Portuguese possessive pronouns may frequently appear before the noun or after the noun (less frequently), and may be preceded by other modifiers such as articles or demonstratives. This is not at all the case in French:

(5) Os livros de Filologia Românica
The books of Romance Philology

(6) Os meus livros de Filologia Românica
The my books

(7) Estes meus livros de Filologia Românica
These my books

Bare nouns are possible with countable and massive nouns (8a and 8b), and so are proper nouns preceded by definite articles:

(8) a. Livros de Filologia Românica, tenho imensos.
Books of Romance Philology, I have many
b. Leite, bebo todos os dias.
Milk, (I) drink everyday

(9) A Maria comprou livros de Filologia Românica
The Mary bought books of Romance Philology

Determiners and clitics

Both languages possess a rich and complex system of inflected determiners and pronominal clitics. In European Portuguese, definite articles, clitic demonstratives and clitic accusative pronouns have the same phonetic realisation: <**o**> [u] [MASC/SING]; <**a**> [a] [FEM/SING]; <**os**> [uʃ] MASC/PL; **as** [ɐʃ] [FEM/PL].

(10) **O**$_{[\text{DEF. ART. MASC}]}$ livro de Filologia Românica, dei-**o**$_{[\text{ACC. PRON}]}$ **à** Maria, **o**$_{[\text{DEMONST. PRON}]}$ de Fonética dei-**o** à Joana.
***The** book of Romance Philology gave **it** to the Mary; **that** of Phonetics gave **it** to the Joanne.*
I gave the book on Romance Philology to Mary, the one on Phonetics to Joann

A similar phenomenon concerns the phonetic identity of clitic accusative pronouns and articles in French: <**le**> [lə] (MASC/SING); <**la**> [la] (FEM/SING) and <**les**> [leʃ] (FEM/MASC/PL).

Nominal and verbal morphological agreement

For reason of readability, Table 1 only contains properties relevant for the further discussion.

Table 1. European Portuguese and French: Similarities and differences

Properties	Portuguese	French
SVO language	X	X
Null subject language	X	
Post-verbal subject in declarative sentences	X	
Pre- or post-nominal possessive pronouns	X	
Definite articles preceding proper noun	X	
Definite articles preceding possessives	X	
Verbal agreement in person and number with the subject	X	X
Nominal agreement in gender and number with determiners	X	X
Identical phonetic form for clitic accusatives and articles	X	X
Identical phonetic form for clitic accusatives, articles and demonstratives	X	

Phonetic properties of definite articles
In both Portuguese and French, the form of the article is monosyllabic. However, in Portuguese it is reduced to a vocalic nucleus (V) in the singular form or to a vowel nucleus followed by a sibilant coda in the plural. In contrast, in French it comprises a consonantal onset and a vowel nucleus (CV) (11–12) both in the singular and in the plural forms that only contrast in the quality of the vowel [ə]SG vs. [e]PL in the masculine form, and [a] vs. [e] in the feminine form:

(11) **o** livro; **os** livros
Le livre; **les** livres
the book; the books

(12) **a** menina; **as** meninas
la fille; **les** filles
the girl; the girls

This might explain the weak perceptibility of the acoustic features for gender in Portuguese mainly in the singular form, depending on each context for co-articulation effects (see Freitas, Matos, Miguel & Faria 1997 studying the effect of syntactic and prosody interaction in the acquisition of Functional Categories in European Portuguese). This might, therefore, contribute to the existence of competition in real-time processing between the regularity of morphosyntactic marking, which conferred a high degree of validity on Portuguese morphology, and a minimal auditory perceptibility of such cues in oral language.

3. Sentence structures and processing hypotheses

The linguistic material consisted of sentences presented in oral modality, displaying some properties that could affect on-line processing. Some of these properties uniformly affect processing in all languages. On the contrary, others are specific to a given language, and so they have a particular impact on sentence processing. For example, morphological and word-order properties can have various weights and produce different constraints as cues for the processor across languages.

The first major purpose of the present study is to evaluate the role of sentential contextual information in the process of children and adults' integration during such processing. Analyzing of the effects of the position of violations (early *vs.* late) within the sentence on the capacity to detect morphosyntactic violations is a useful approach as regards this factor. Research carried out on this topic in English and Italian has shown that, all things being equal and whatever the nature of the violation, violations appearing later in the sentence are more rapidly detected

by both normal and aphasic subjects than those placed earlier in the sentence (Wulfeck et al. 1991; Wulfeck 1993). These data have been confirmed in our studies on Modern Greek (Kail & Diakogiorgi 1998), French and English (Kail 2004a, 2004b). This effect has been interpreted as indicating the subjects' capacity to use their grammatical knowledge to construct hypotheses about the process of integrating linguistic information while processing.

Secondly, it is presumed that on-line processing procedures are affected by the structural constraints linking the internal elements of the sentence. Thus, in all languages, it is to be expected that violations concerning the internal elements of a single syntactic unit (e.g., a violation of gender between the article or adjective and the noun in French or Portuguese) are more easily and quickly detected than those affecting elements in distinct phrasal constituents (e.g., a violation of number between the subject and the verb). For example, violations belonging to the same constituent of the sentence may facilitate the immediate comparison between them and the expected forms. Consequently, weighing problems for working memory due to violation occurring between distinct components will be reduced. In French, Kail (2004a) has shown that this structural factor (*violation span*) is more effective in adult subjects and in children after the age of 10. This has confirmed the results of a previous study (Lambert & Kail 2001) which showed that the intraphrasal violations of nominal agreement are more quickly detected than the interphrasal ones of verbal agreement.

In Portuguese, the high validity of nominal agreements may be reduced by weak auditory perceptibility of such cues in oral language resulting in a competition which slows down the detection of ungrammaticality of noun–article combinations.

Finally, the last factor we examine, *violation type,* concerns how morphological agreement cues and word-order cues are integrated in real time in both languages. The hypothesis is as follows: the subjects' capacity to detect violations affecting certain cues needs to be linked to cue validity and to cue strength within the respective language. Costa (2005) explained how morphological agreement cues have a predominant strength in the off-line processing in European Portuguese. As in French, their violation should be more readily detected in real time than word-order violations. However, it should be stressed that such detection is not a simple function of cue validity. It also depends on relationships between morphology and word-order in the respective language, and on the probability that word order and morphological cues may contribute together to assign syntactic and semantic functions. To sum up, three aspects are analyzed: (i) the position of the violation: early (p1) *vs*. late (p2); (ii) the violation span: intraphrasal (s1) *vs*. interphrasal (s2); (iii) the violation type: morphological agreement (t1)

vs. word-order (t2). Sentences corresponding to (i) (ii) and (iii) are given in the Method Section. Here we give some examples of factors combinations.

(13) Example of late interphrasal and verbal agreement violation (t1s2p2):
Chaque samedi, après avoir été au marché, la voisine[SG] rempli**ssent**[3rd;PL] le frigo.
Aos sábados, depois de ir ao mercado, a vizinha[SG] ench**em**[3rd;PL] o frigorífico.
Every Saturday, after going to market, a neighbor[SG] ***fill*** [3rd;PL] *the fridge*.

(14) Example of early intraphrasal and word order violation (t2s1p1):
Chaque samedi, voisine[FEM] **la** remplit le frigo, après avoir été au marché.
Aos sábados vizinha[FEM] **a** enche o frigorífico depois de ir ao mercado.
Every Saturday, neighbor ***a*** *fills the fridge after going to market*

4. Method

We first constructed fourty grammatical sentences for each language. Second, for the French version of the study, we constructed for each grammatical sentence eight ungrammatical sentences with the same vocabulary but varying according to the three parameters mentioned above, i.e. (i) the position of the violation: early (p1) *vs*. late (p2); (ii) the violation span: intraphrasal (s1) *vs*. interphrasal (s2); (iii) the violation type: morphological agreement (t1) *vs*. word-order (t2). This amounts to a total of 360 sentences. Table 2 illustrates a French grammatical sentence (baseline condition) with the corresponding eight ungrammatical sentences (experimental items).

In Portuguese, the interphrasal change from Subject-Verb order to Verb-Subject order does not produce an ungrammatical construction as in French. For this reason, the Portuguese stimuli did not include the V-SN sentences. There were 240 ungrammatical sentences analysed for Portuguese. Table 3 illustrates a Portuguese grammatical sentence (baseline condition) with the corresponding six ungrammatical sentences (experimental items).

Eight lists of 40 grammatical and 40 ungrammatical sentences were generated. Each participant was assigned to one list and processed 80 experimental items and 32 fillers. Monolingual participants were divided into four age groups with 16 participants in each language. The mean age groups were 6;8, 8;6 and 10;10 and in addition 16 university students were tested as adult controls. All participants were native speakers of Portuguese or French, attending schools/universities in Lisbon and Paris.

Table 2. French sentences

Grammatical sentence		***Chaque semaine, la voisine remplit le frigo après avoir fait les courses au marché.*** **Every week, a neighbour fills the fridge after going to the market.**
1	t1s1p1	*Chaque semaine, **le** voisin**e** remplit le frigo après avoir fait les courses au marché.*
2	t1s1p2	*Chaque semaine, après avoir fait les courses au marché **le** voisin**e** remplit le frigo.*
3	t1s2p1	*Chaque semaine, la voisine rempl**issent** le frigo après avoir fait les courses au marché.*
4	t1s2p2	*Chaque semaine, après avoir fait les courses au marché, la voisine rempl**issent** le frigo.*
5	t2s1p1	*Chaque semaine, voisine **la** remplit le frigo après avoir fait les courses au marché.*
6	t2s1p2	*Chaque semaine, après avoir fait les courses au marché voisine **la** remplit le frigo.*
7	t2s2p1	*Chaque semaine, **remplit la voisine** le frigo après avoir fait les courses au marché.*
8	t2s2p2	*Chaque semaine, après avoir fait les courses au marché **remplit la voisine** le frigo.*

Table 3. Portuguese sentences

Grammatical sentence		***Aos sábados, a vizinha enche a despensa depois de ir ao mercado.*** **Every Saturday, a neighbour fills the fridge after going to the market.**
1	t1s1p1	*Aos sábados, **o** vizinh**a** enche a despensa depois de ir ao mercado.*
2	t1s1p2	*Aos sábados, depois de ir ao mercado, **o** vizinh**a** enche a despensa.*
3	t1s2p1	*Aos sábados, a vizinha ench**em** a despensa depois de ir ao mercado.*
4	t1s2p2	*Aos sábados, depois de ir ao mercado a vizinha ench**em** a despensa.*
5	t2s1p1	*Aos sábados, **vizinha a** enche a despensa depois de ir ao mercado.*
6	t2s1p2	*Aos sábados, depois de ir ao mercado, **vizinha a** enche a despensa.*

Grammaticality judgments and detection times were measured from the offset of the word that cause ungrammaticality and were registered by the experimental software PsyScope (Cohen, MacWhinney, Flatt & Provost 1993). All the sentences were recorded in French and in Portuguese by two native female speakers. The recording of the Portuguese sentences was carried out at the Psycholinguistic Laboratory of the Faculty of Letters, University of Lisbon. In order to evaluate coarticulation problems in the ungrammatical sentences with article/noun inversion, some particular tests using spectrograms were applied. For example, in the experimental sequence ***vizinha a*** (*a vizinha* being the canonical control), there is a doubling of the vowel [ɐ], the feminine morpheme closing the noun and the feminine article in the post-nominal position (there are similar conditions with the masculine nouns: **vizinho o**, with the final vowel sequence being produced as [u|u] or as [u:]). This gives rise either to the phonetic realization of [ɐ|ɐ] or to the lengthening of the final vowel [ɐ:]. This last phonetic realization can mask the ungrammaticality of the condition with the postponed article, especially considering the possibility to have a bare noun.

Participants were tested individually in sessions lasting around 20 minutes. After practicing with 8 sentences, they listened to 112 sentences (both experimental sentences and fillers) randomly presented. Subjects were asked to decide as quickly as possible whether the sentence was correct (green button) or incorrect (red button). They were instructed to be as attentive as possible, since each sentence would only be produced once.

5. Results

Detailed statistical analyses of French results were presented in Kail (2004a) and not reproduced here. On the contrary, new results obtained in Portuguese were presented with the corresponding ANOVAS: one with participants (F1) and one with items (F2) as the random factor.

5.1 Undetected violations

From the age of 6, children in both languages were able to detect grammatical violations showing judgments that were beyond mere chance. It should be noted that the undetected violations rate of the Portuguese subjects at all ages was higher.

A global developmental effect is attested by a significant reduction of undetected violations in both languages with age: in French, 25.3% at the age of 6;8; 19.9% at 8;6; 17.9% at 10;10 and 3.7% among young adults and in Portuguese,

41% at 6;8years of age; 28.2% at 8;6; 21.4% at 10;10 and 11% for the young adults. In Portuguese, the error rates showed a main effect of age $F1(3,54) = 21.50$, $p < .00001$, $F2(3,156) = 9.77$, $p < .00001$. The following results were obtained in age group comparisons: 6;8 years *vs.* 8;6 years ($F1(1,24) = 7.89$, $p < .0009$, $F2(1,78) = 2.56$, ns); 8;6 years *vs.* 10;10 years ($F1(1,30) = 4.12$, $p < .004$, $F2(1,78) = 5.15$, $p < .002$) and 10;10 years *vs.* adults ($F1(1,30) = 11.98$, $p < .0001$, $F2(1,78) = 9.32$, $p < .0004$). The main developmental changes took place between 6.8 years and 8;6 years.

In French, a significant effect for violation span was obtained with greater sensitivity for intraphrasal violations compared to interphrasal violations. This effect decreased with age and the difference disappeared in the oldest children (10;10 years). In Portuguese, there was also a main significant effect of violation span ($F1(1,54) = 52.52$, $p < .00001$, $F2(1,156) = 23.84$, $p < .00001$). Intraphrasal violations were more often detected than interphrasal ones at each age level: at 6; 8 years ($F(1,9) = 8.05$, $p < .0018$, $F2(1, 39) = 2.14$, ns); at 8;6 years ($F(1,15) = 11.78$, $p < .0003$, $F2(1,39) = 10.53$, $p < .0002$); at 10;10 years ($F1(1,15) = 24.87$, $p < .00001$, $F2(1,39) = 17.99$, $p < .00001$ and in adults ($F1(1,15) = 18.98$, $p < .00006$, $F2(1,39) = 9.04$, $p < .0004$.

In French, there was no effect of violation type: children did not make more undetected violations for agreement violations than for word order violations. On the contrary, in Portuguese, there was a main effect of violation type: $F1(1,54) = 41.74$, $p < .00000$ $F2(1,156) = 40.08$ $p < .00000$. Agreement violations were more often detected than word order violations at each age level: at 6; 8 years ($F(1,9) = 17.54$, $p < .0002$, $F2(1, 39) < 1$, ns); at 8;6 years ($F(1,15) = 5.20$, $p < .003$, $F2(1,39) = 6.68$, $p < .001$); at 10;10 years ($F1(1,15) = 12.99$, $p < .0002$, $F2(1,39) = 35.36$, $p < .00000$ and in adults ($F1(1,15) = 40.93$, $p < .00000$, $F2(1,39) = 23.18$ $p < .00000$. Such a result was in accordance with the high validity of morphology in Portuguese sentence processing (Costa 2005).

Finally, in both languages, the main effect of violation position did not reach significance. In accordance with previous results in English (Wulfeck 1993) children did not show a better sensitivity to violations coming late in the sentence.

As shown in Figure 1, the qualitative analysis of undetected violations as regards each structure (8 structures in French and 6 in Portuguese) revealed the systematization of undetected violations throughout the various age groups in both languages. Some structures elicited a greater number of undetected violations than others. In particular, structures containing interphrasal violations (s2) seemed to overload working memory.

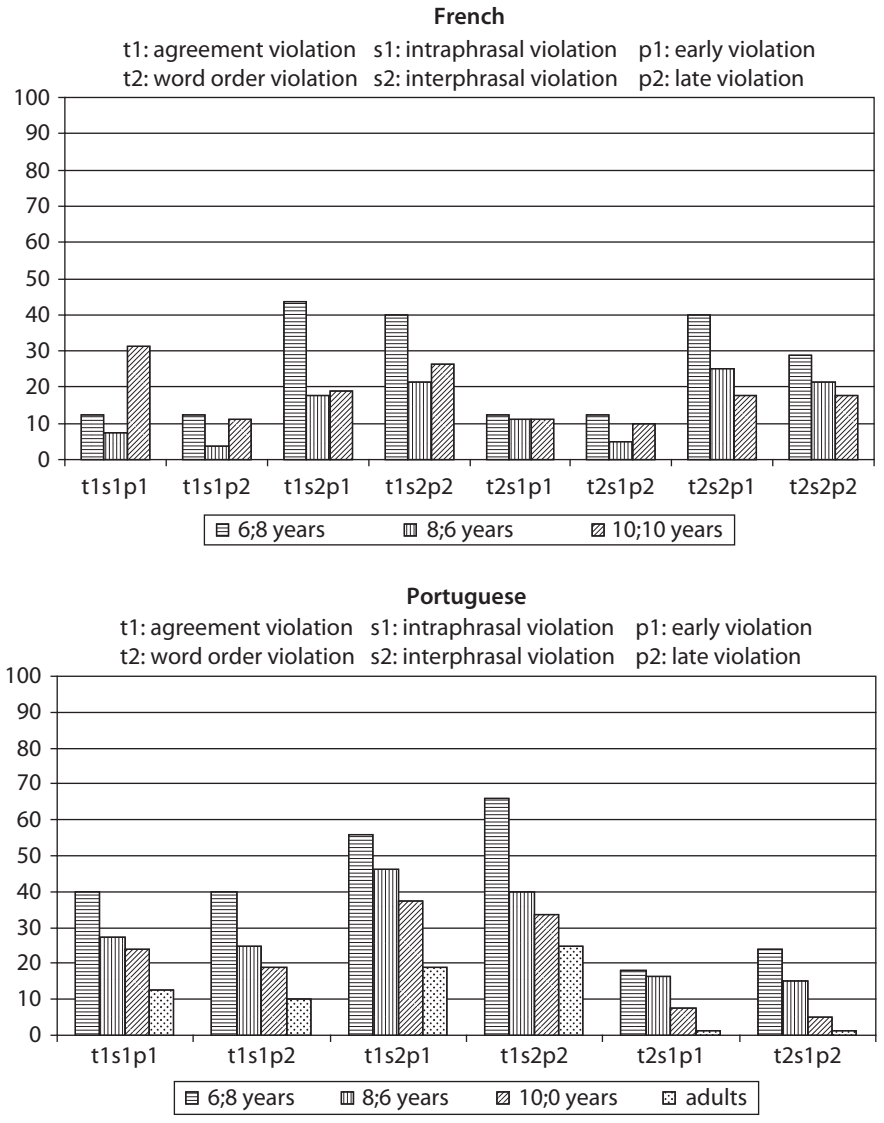


Figure 1. Undetected violations as a function of age and violation structure

5.2 Detection times

The classical compromise between accuracy and processing speed has to be taken into consideration in this judgment task. As regards detection times of grammatical violations, the developmental effect was far more marked in French than in Portuguese. Mean detection times were as follows for French: 2594 ms at 6;8 years

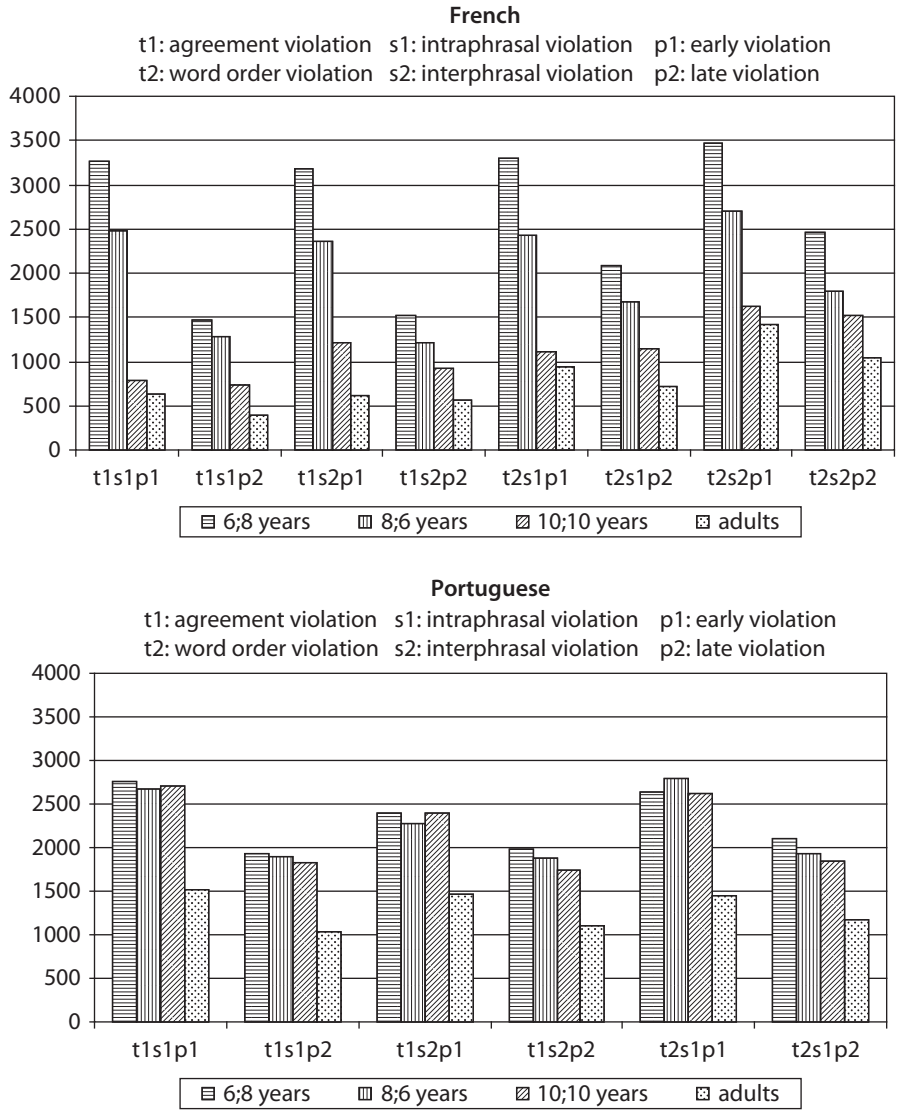


Figure 2. Mean detection times (ms) as a function of age and violation structure

old; 1992 ms at 8;6; 1131 ms at 10;10 and 791ms for adults. In Portuguese there was no significant detection time differences between children groups: 2301 ms at 6;8 years; 2241 ms at 8;6; 2192 ms at 10;10. A significant difference was observed between the oldest group (10;10) and the adults (1288 ms) ($F1(1,30) = 45.88$ $p < .00000$, $F2(1,78) = 392.32$, $p < .00000$.

In both languages, the global analysis of detection times for each structure under study revealed that violation position was a very important factor: all structures involving late violations resulted in shorter detection times, as can be seen in Figure 2.

As in other studies using the same paradigm, it can be seen from Figure 1 and Figure 2 that accuracy and processing speed were differently affected by the experimental factors.

5.2.1 *Sentential context and on-line sentence processing*

In conformity with previous results obtained in English (Wulfeck 1993) and in French (Kail 2004a), the capacity of Portuguese subjects to detect grammatical violations was not affected by violation position. In other words, regardless of age, violations occurring late in the sentence were not more often detected than those occurring earlier in the sentence.

On the other hand, as predicted, when violations were correctly detected, those that were late in the sentence were detected significantly more quickly than those occurring earlier. In Portuguese, there was a significant main effect of the position of the violation: ($F1(1,54) = 156.16$, $p < .00000$, $F2(1,156) = 370.62$, $p < .00000$). Late violations were more rapidly detected than earlier ones at each age level: at 6; 8 years ($F(1,9) = 27.06$, $p < .00006$, $F2(1, 39) = 49.68$, $p < .00000$; at 8;6 years ($F(1,15) = 91.65$, $p < .00000$, $F2(1,39) = 118.77$, $p < .00000$); at 10;10 years ($F1(1,15) = 127.88$, $p < .00000$, $F2(1,39) = 193.49$, $p < .00000$ and in adults ($F1(1,15) = 8.77$, $p < .0009$, $F2(1,39) = 51.96$ $p < .00000$.

As shown in Table 4, this robust result was found at all ages for both languages. This result clearly showed that subjects were able to efficiently integrate linguistic information conveyed by the sentential context during on-line processing.

Although there was no interaction between position and the other factors in French, we found a significant interaction between violation position and violation span in Portuguese analyzed on the next paragraph.

Table 4. Detection times (ms) as a function of violation position and age

	French		Portuguese	
	Early	**Late**	**Early**	**Late**
6;8	3306	1881*	2598	2004*
8;6	2495	1488*	2583	1899*
10;10	1185	1078*	2582	1802*
Adults	903	679*	1478	1098*

* Significant differences (F1 & F2).

5.2.2 *Structural constraints and on-line sentence processing*

An important general effect of violation span in French showed a greater capacity for detecting intraphrasal violations (involving word-order and agreement violations between the article and the noun) than interphrasal violations (involving word-order and agreement violations between the subject and the verb). There was a strong interaction between violation span and age. Indeed, if children's detection of intraphrasal violations was better than their detection of interphrasal violations, this discrepancy disappears by the age of 10;10 (see Kail 2004a for a detailed analysis of French).

As we mentioned earlier, the analysis of undetected violations in Portuguese globally corroborated the results for French: intraphrasal violations were significantly more often detected than interphrasal ones at all ages. It should be remembered, however, that the Subject-Verb word-order change is not ungrammatical in Portuguese. The violation span effect did not interact with age and seemed to be relatively robust in Portuguese.

Nevertheless, the analysis of detection times in Portuguese shed new light on a specific phenomena: we found a significant main effect of violation span indicating that intraphrasal violations were less quickly detected than interphrasal violations ($F(1,54) = 15.43$, $p < .00003$, $F2(1,156) = 4.57$, $p < .003$). This effect was significant at 8;6 years ($F(1,15) = 18.37$, $p < .00007$, $F2(1,39) = 5.03$, $p < .002$); at 10;10 years ($F1(1,15) = 4.55$, $p < .004$, $F2(1,39) = 7.56$, $p < .0008$ but was not significant in the youngest group nor in adults.

This result contradicted hypotheses formulated for Portuguese based on off-line data (Costa 2005), as well as the data collected for both French (Kail 2004a), English (Wulfeck et al. 1991; Wulfeck 1993; Kail 2004b) and Swedish (Kail, Kihlstedt & Bonnet, in press).

In order to understand this specific result, the acoustic phonetic properties of the structure must be examined: **a vizinha** [ɐviˈziɲɐ] becomes **vizinha a** [viˈziɲɐ|ɐ]. Despite checks being carried out when recording the sentences, this inversion may result in an ambiguous phonetic production, that could induce an

Table 5. Detection times (ms) as a function of violation span and age

	French		Portuguese	
	Intraphrasal	**Interphrasal**	**Intraphrasal**	**Interphrasal**
6;8	2528	2660	2358	2188*
8;6	1965	2018	2322	2079*
10;10	943	1319*	2252	2072*
Adults	669	912*	1291	1280

* Significant differences (F1 & F2).

hesitation in the interpretation between a clearly ungrammatical structure or a more acceptable one if the final vowel sequence is interpreted as a lengthening of the final word vowel. In this case we could expect a slowdown effect in the identification of word-order violations. This problem does not occur in French where the article is expressed as a consonantal group: **la voisine** *vs*. **voisine la**. On the other hand, even when the Article-Noun order is respected but morphological violation of gender occurs (**o**$_{[\text{MASC}]}$ **vizinha**$_{[\text{FÉM}]}$ instead of **a**$_{[\text{FÉM}]}$ **vizinha**$_{[\text{FÉM}]}$), the weak phonetic weight of the article, which is reduced to a vocalic nucleus, may prevent the perception of ungrammaticality.

There was a significant interaction between violation span (intra *vs*. interphrasal) and violation position (early *vs*. late) $F1(1,54) = 83.97$, $p < .00000$, $F2(1,156) = 114.37$, $p < .00000$. This interaction revealed that at all ages detection times were shorter for interphrasal violations only when early violations were concerned. At 6; 8 years ($F(1,9) = 15.18$, $p < .0003$, $F2(1,39) = 26.53$, $p < .00000$; at 8;6 years ($F(1,15) = 53.15$, $p < .00000$, $F2(1,39) = 47.92$, $p < .00000$); at 10;10 years ($F1(1,15) = 23.88$, $p < .00002$, $F2(1,39) = 59.72$, $p < .00000$ and in adults ($F1(1,15) = 5.19$, $p < .003$, $F2(1,39) = 3.72$ $p < .005$.

Within this violation paradigm our results showed that it is important to consider the relative weight of two different types of constraints: grammatical constraints linked to properties of word-order and agreement cues within the language, on the one hand, and perceptive constraints linked to the perceptibility of the violations, on the other hand. In Portuguese, the strength of morphological cues was modulated by their low perceptibility.

5.2.3 *Cue validity and on-line sentence processing*

As previously mentioned, there are substantial variations within and between languages in terms of accuracy and detection times. An illustration of this discrepancy difference was provided by the contrast between morphological agreement violations and word-order violations.

In French, as shown by previous studies of cue validity in off-line processing (Kail & Charvillat 1988; Kail 1989), morphological violations were far more quickly detected at all ages than word-order violations. This effect was particularly marked in older subjects.

In Portuguese, on-line results did not confirm predictions based on off-line processing (Costa 2005). Indeed, except for children of 8;6 who were able to detect morphological violations more quickly than they detected word-order violations ($F1(1,15) = 9.95$, $p < .0006$, $F2(1,39) = 6.33$, $p < .001$), the differences merely correspond to tendencies. The global interaction between violation type and violation position ($F1(1,54) = 30.33$, $p < .00000$, $F2(1,156) = 36.20$, $p < .00000$) was significant for older children (10;10) ($F1(1,15) = 26.98$, $F2(1,39) = 18.95$, $p <$

Table 6. Detection times (ms) as a function of violation type and age

	French		Portuguese	
	Agreement	**Word order**	**Agreement**	**Word order**
6;8	2356	2831*	2267	2370
8;6	1833	2151*	2180	2363*
10;10	911	1351*	2170	2235
Adults	555	1026*	1277	1308

* Significant differences (F1 & F2).

.00001), and adults ($F1(1,15) = 8.44$, $p < .001$, $F2(1,39) = 11.33$, $p < .0001$ This interaction showed that morphological violations benefit from their late position, but not word-order violations. Wulfeck (1993) reported similar results for English. Children produced faster detection times for late occurring word-order violations compared to agreement violations. To summarize: the more valid (reliable) the cue, the more efficient the sentential context.

An examination of the relative weight of cues in French revealed significant changes as a function of age. At 6;8 and 8;6 the most crucial cue was violation position. Later violations were more quickly detected than earlier ones: 1881 ms *vs.* 3306 ms (6;8 years old); 1488 ms *vs.* 2495 ms (8;6 years old). The second important cue was violation type. Morphological violations were more quickly detected than word-order violations: 2356 ms *vs.* 2831 ms (6;8 years old) and 1832 ms *vs.* 2150 ms (8;6 years old). At these ages, violation span had no significant effect. At the age of 10;10, detection times significantly decreased and the hierarchy of cues changed. Violation type became the dominant cue: violations of agreement were more quickly detected than word- order ones (911 ms *vs.* 1350 ms) and violation span becomes relatively important, i.e., intraphrasal violations were detected significantly more quickly than interphrasal ones (943 ms *vs.* 1319 ms). Contrary to results observed in the youngest children, violation position no longer had any real effect. French adults followed the same hierarchy: violation type remained the dominant cue (agreement 555 ms *vs.* word order 1026 ms), followed by violation span (intraphrasal 669 ms *vs.* interphrasal 912 ms) while violation position was still an important cue (early 902 ms *vs.* late 678 ms). The hierarchy of cues pointed out an increasing dependency on morphology in on-line sentence processing.

In Portuguese, cue hierarchy seemed to be established from 6 years on. At 6;8 only violation position was important enough to affect processing in a significant way (late violations, 2004 ms vs. early ones, 2598 ms). At 8;6 violation position remained the dominant cue (late 1899 ms *vs.* early 2583 ms). The two other cues involving violation span (intraphrasal 2322 ms *vs.* interphrasal 2079 ms) and violation type (agreement 2180 ms *vs.* word order 2363 ms) played a less

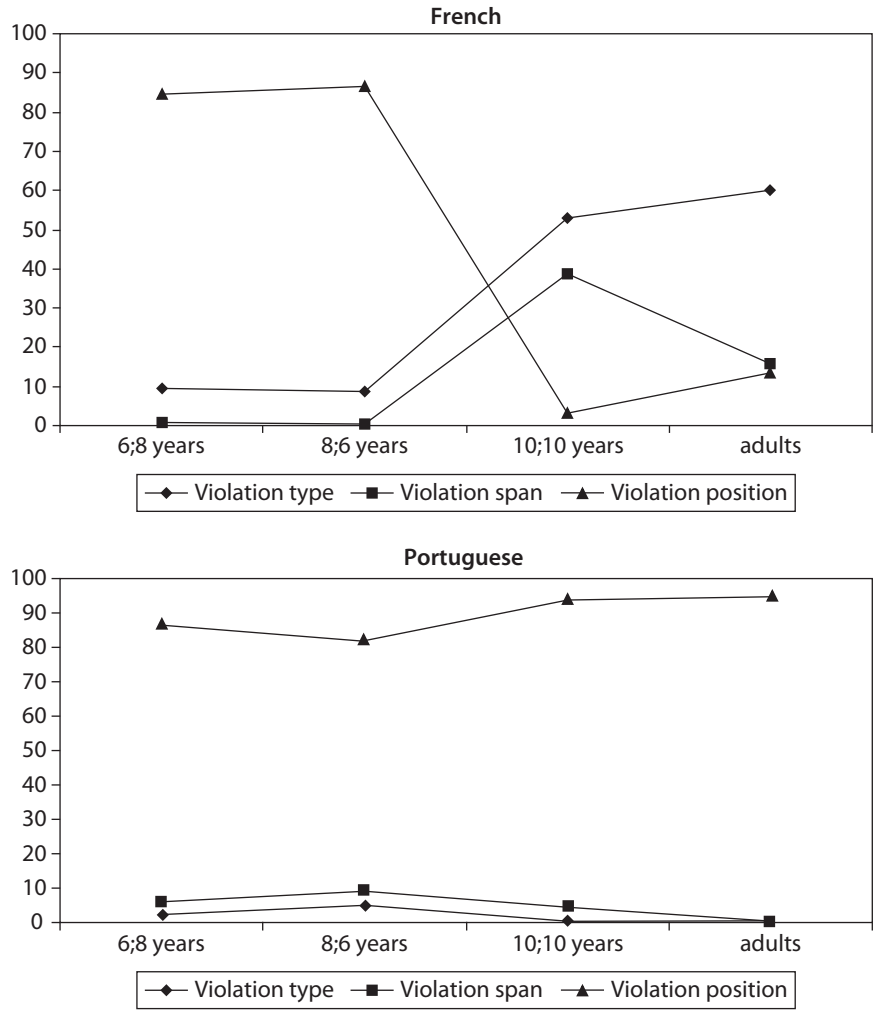


Figure 3. Percentage of detection times variances resulting from main effects in each age group

important role. At 10;10 the crucial cue was violation position (late 1802 ms *vs.* early 2582 ms) and violation span continued to cause unexpected results (intraphrasal 2252 ms *vs.* interphrasal 2072 ms). Finally, for adults, only violation position was a relevant factor (late 1098 ms *vs.* early 1478 ms).

These developmental phenomena have been analyzed with a specific ANOVA for each language. The variance explained by the three factors including all interactions was estimated for each age group (Ss Effect/Ss Total). The results of these analyses are shown in Figure 3. In French the fundamental developmental

change occurred between 8;6 and 10;10; at this age violation position stopped to be dominant (shifting from explaining 85% of variance to 10%). Violation position was replaced mainly by violation type (50% to 60%) followed by violation span (30%). In Portuguese, violation position explained between 80% and 90% of the variance at all ages.

This study showed that French and Portuguese do not behave in the same way, mainly as regards the hierarchy of cues used in on-line language processing during development.

6. Discussion and conclusion

As predicted, late violations were detected much more quickly than early ones, in both languages and in all age groups. This suggests that the facilitation effect linked to late position allowed a high degree of systematization. A similar result was found in other languages in our program (English, Swedish, Polish) and confirmed previous results obtained in Italian (Wulfeck et al. 1991). From 6 years on, subjects used their grammatical knowledge to construct hypotheses throughout their processing; they made valuable use of the morphosyntactic sentential context to anticipate what will happen in the coming input. On-line sentence processing seemed to be governed by some universal constraints.

In the various languages we have studied, intraphrasal violations were detected significantly more rapidly than interphrasal violations. Such a result underlined the fact that on-line processing is dependent on the structural constraints of sentences which required working memory capacities in a differential mode. It indicated that cue cost may be more decisive than cue validity in on-line sentence processing. The overall influence of sentence structure was modulated by the linguistic properties of each language and by its interaction with other constraints. The specific result concerning the role of sentence structure in Portuguese seemed to be linked to difficulties in auditory perception caused by phonetic properties in the oral modality. Thus, these violations were weakly perceptible and their detection became particularly difficult. Furthermore, the fact that Portuguese subjects showed slower detection times than French subjects, and that they had more difficulty to detect ungrammaticality, may call attention to other explanations in addition to linguistic constraints themselves. Another explanation referred to a morphosyntactic difference between Portuguese and French, i.e. the fact that Portuguese, but not French, allowed the occurrence of nouns without determiners in specific contexts. This property might constitute an additional factor that influenced detection times in Portuguese.

These results lead us to make some additional remarks. In Portuguese, it would be advisable to gather data based on violations with good auditory perceptibility. Nevertheless, it is not easy to fulfill this requirement given the linguistic properties that are inherent to the language itself. Indeed, the frequency of feminine nouns ending in "a" and preceded by the article "a", and of masculine nouns ending in "o" and preceded by the article "o", is extremely high. The choice of such nouns in the experiment was perfectly representative of the nominal Portuguese lexicon. However, it could be useful to conduct a control experiment in order to understand what depends on the linguistic material used and what can be generalized from the linguistic properties of the language under study.

The typological proximity of the two languages and the confirmed weight of morphology in their off-line processing should have allowed for a greater similarity in on-line processing. The validity of morphological cues was a good predictor for real time processing in French, but this is not the case in Portuguese. The results indicated the relative precedence of morphology at all ages, although this effect did not reach a significant threshold. As previously shown for Greek (Kail & Diakogiorgi 1998), the validity of cues may enter into competition with their perceptibility during real time processing. Kempe and MacWhinney (1999) have convincingly demonstrated that languages such as German and Russian, which present a rich morphological system, trigger different on-line sentence strategies. Conversely, we have shown (Kail 2004b) that languages which greatly contrast (such as English and French) may require similar on-line sentence strategies.

The Portuguese results suggest the need to take into account perceptual components in the proposed principles for on-line sentence processing. Cue validity could be highly constrained by cue cost and the relationship between cue validity and cue cost could be more complex than previously stated in the CM. The reality of sentence processing in real time is complex and more developmental crosslinguistic studies are necessary to provide new insights.

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CHAPTER 11

The expression of finiteness by L1 and L2 learners of Dutch, French, and German

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Finiteness is traditionally associated with the morpho-syntactic categories of person and tense. The notion of finiteness has however much wider, semantic and pragmatic ramifications, a fact which has led several researchers to make a distinction between M(orphological) and S(emantic) finiteness. We follow this distinction here.

Over the last decade language acquisition researchers have analysed the expression of finiteness from different theoretical standpoints, mainly examining learners' verbal production in comparable tasks, ranging from spontaneous conversation to more guided complex verbal tasks. With the same methodology, we will examine the acquisition of finiteness by adult learners of French L2 in cross-linguistic comparison with learners of Germanic L2s. The adult acquisition process will also be compared to the child's acquisition of finiteness in the L1 for the same target languages. All languages in the sample mark finiteness by means of verbal morphology. We will describe the acquisitional paths towards the TL system and the various stages learners pass through on the way. Finally, we ask whether the difference in mastery of the target system by these two types of learners – children achieve mastery of the relevant verbal morphology whereas adults often do not – can throw light on the organisation and functioning of finiteness in language in general.

1. Introduction

Finiteness is traditionally associated with the morpho-syntactic categories of tense and person. The notion 'finiteness' should however be considered in a broader perspective as it has semantic and pragmatic ramifications, a fact which has led several authors (e.g. Lasser 1997; Maas 2004) to propose a distinction between M(orphological)-finiteness and S(emantic)-finiteness. We will attempt to justify the relevance of this distinction for a description of the acquisitional process.

The acquisition of finiteness has been analysed from a (mainly) formal perspective over the past decade, by comparing learners' spontaneous or more guided oral productions over time. Using the same methodology, we examine and compare the acquisition by L1 and L2 learners of French, Dutch and German, all languages which mark finiteness by verbal morphology. We describe the successive steps in the acquisition process, and ask to what extent the remarkably different success rate between child (L1) and adult (L2) learners can help us better to understand the functioning of finiteness itself.

2. The case of *auch*

French, Dutch and German make a distinction between finite (je *donne*, ik *geve*, ich *gebe*) and non-finite (pour *donner*, te *geven*, zu *geben*) forms of the verb, and this distinction has to be acquired. Several authors have pointed out that the distinction represents a major acquisition task, which is not merely restricted to verbal morphology. This is particularly clear in the case of German and Dutch, where the finite verb form is the second major constituent of the main clause ('V2') and the non-finite form occurs in the so-called right bracket. Nederstigt (2002) summarises word order regularities in German as shown in Table 1.

The pre-field contains just one major constituent, and if that constituent is not the subject (e.g. 'yesterday', 'there') then the subject (e.g. 'Lisa', 'the red ball') moves to the middle field. If there is no auxiliary, then the finite lexical verb occurs in the left bracket (*passt*: 'fits'), separated from its particle ('rein') in the case of phrasal verbs. (This simplified description is, for our purposes, also valid for Dutch.)

Table 1. Word order in German main clauses (Nederstigt 2002)

Pre-field	**Left bracket: V_{FIN} ('V2')**	**Middle field**	**Right bracket: V_{INF}**	**Post-field**
Lisa '*Lisa*	hat *has*	mit ihrer Puppe *with her doll*	gespielt *played*'	
Gestern '*Yesterday*	hat *has*	L. mit ihrer Puppe *L. with her doll*	gespielt *played*'	
Gestern '*Yesterday*	hat *has*	Lisa *Lisa*	gespielt *played*	aber ohne Puppe *but without her doll*'
Da '*There*	passt *fits*	die rote Kugel *the red ball*	rein *in*	ohne Problem *without problem*'

Table 2. L1 acquisition of German main clauses (18–40 months): VP > IP > CP

1. (nein)	Mama *'mummy*	***Auch*** *also*	Tür Tür (the) door	***auf*** ***aufmachen*** *open'*
2.	Mama *'mummy*	***kann*** can	(die) Tür *(the) door*	***aufmachen*** *open'*
3. Wenn *'if*	mama *mummy*		die Tür *the door*	***aufmacht*** *opens'*

How does the learner acquire such a complex organisation? Tracy (1991, 2005), and many other authors (Radford 1990, under the heading of 'minimal trees'; Meisel 1994), associate the acquisition of finite verb morphology with a 'Structure-building' view of L1 development. The functional categories associated with finiteness – person and tense – and those associated with a sentence's left periphery – complementisers, WH-phenomena – have to be acquired. The order of acquisition is implicational: from VP, functional categories are built up according to a syntactic hierarchy VP > IP > CP, with the implicational constraints that IP must be acquired before acquisition of CP can commence.[1]

Tracy (2005) summarises the German L1 data (see Table 2).

Stage 1 shows VP organisation, with the particle and/or the lexical verb in final position, and the negator outside VP; stage 2 represents the acquisition of finite auxiliaries ('can', etc.) and thus the beginning of the finite/non-finite contrast. Here, the negator would occur after the finite verb; stage 3 shows the acquisition of complementisers and subordinate clauses, where in German the finite verb occurs clause-finally. There is thus a strong interaction between the acquisition of the morphological oppositions and the acquisition of word order. For the acquisition of L2 German, Parodi (2000) has also convincingly shown a tight relation between the acquisition of finite verb morphology and the acquisition of word order.

This is not the only possible account of the (German and Dutch) acquisition process. Others have argued that learnability considerations suggest a UG-given syntactic tree from the very beginning of grammatical acquisition, including the whole set of hierarchically ordered, functional nodes. For acquisitional data to be compatible with a basically target-like tree configuration, the underspecification of individual nodes (Wexler 1994 and onwards) or the truncation of the syntactic tree (Rizzi 1994; Hamann 1996) have been proposed. We will return to this in Section 6.

1. Much in the spirit of Meisel, Clahsen & Pienemann (1981).

Now, in Tracy's stage 1, there occurs the word *auch* ('also'). Penner, Tracy and Weissenborn (2000) were the first to notice that, when finite verb forms are first acquired (stage 2), they are absent from utterances containing *auch,* as in the following example:

(1) Alle hamen Augen … Sabine ***auch*** Augen (Penner et al. 2000: 8)
(*all have*-FIN *eyes … Sabine also eyes*)

This observation is confirmed in other studies – Lasser for L1, and Dimroth for L2:

(2) Mone ***auch*** Löffel haben (Simone 2;0, from Lasser 1997: 203)
(*Simone also spoon have*-INF)

(3) und die Mädchen und der Chaplin ***sind*** aufgestanden
(*and the girl and Chaplin have (are*-FIN*) stood up*-PP)
und die Polizei ***auch*** aufgestanden
(*and the police(man) also stood*-PP *up*) (Cevdet, intermediate-level learner of German L2, retelling Chaplin's 'Modern Times', from Dimroth 2002)

Nederstigt's (2002) thesis on the acquisition of *auch,* is a longitudinal study starting from the very first utterances of the German child Caroline. She finds that (stressed) *auch* is attested already from 1;06 on, and that up until age 2;00, less than 20% of Caroline's utterances contain a verb. *Auch* is thus used very precociously, before VP construction is fully in place. There is therefore some reason to split Tracy's stage 1 (VP) into a full VP stage, preceded by a stage where *auch* (and *nein*) are already productive:

Nederstigt: AUCH > $V_{INF\ (=VP)}$ > $V_{FIN\ (=IP)}$

3. Other candidates for the left bracket in L1

The observations of §1 suggest that Tracy's stage 1 – VP – takes some time to become systematic, and that *auch* somehow interferes in the transition from stage 1 to stage 2. Two obvious questions then arise: (i) why should *auch* be involved in the acquisition of the finite morpho-syntax of German? (ii) are there other items which behave like *auch* over time? These questions were investigated by Dimroth, Gretsch, Jordens, Perdue & Starren (2003, see also Jordens 2002; Gretsch 2000; Gretsch & Perdue 2007) for German and Dutch. Their findings are briefly summarised below, but after a cautionary note on methodology.

3.1 Methodology

The results presented in this paper are based on (more or less spontaneous) production data. The problem then arises of the contextual interpretation of the attested utterances. Such corpus data pose of course not only the traditional problem of interpretation (how can one be sure of the communicative intentions of a toddler?), but also the problem of completeness (does the corpus entirely reflect the learner's capabilities?), and, related to this, of productivity (what are the criteria, given a limited corpus, allowing the researcher to say that a particular item or rule is acquired?).

These problems are compounded by the tendency shown by some (often formalist) researchers to interpret learner utterances as closely as possible to a 'corresponding' TL utterance, with the risk of (over-)interpreting learner performance in the direction of TL categories. This problem becomes even more acute the more one wishes to attribute 'UG-given' knowledge to the beginning learner. Thus from a methodological problem arises a more theoretical mirror-problem of deciding what the initial state of a (child or adult) learner is, and whether it is more parsimonious to assume a strong (innate) interpretation of UG-given knowledge, or not.

Such problems are nevertheless mitigated in the data discussed below by the longitudinal perspective adopted, which allows an analysis of comparable performances over time. This comparability is enhanced in the case of adult learners by direct comparison over time of the same complex verbal tasks, such as narratives, retellings, and the like, where the communicative intention of the speaker is to some extent verifiable. But for child language utterances, their interpretation and representativity pose a general challenge, especially during the earliest stages of L1 acquisition. We may however say that the utterances discussed below are representative, to the extent that they are tokens of utterance-types attested independently by different observers.

3.2 L1 utterances: German and Dutch

The following tables are taken from longitudinal studies by Gretsch (2000) and Jordens (2002) from the stage where the children are beginning to produce modal-like verbs (akin to Tracy's *kann*) in the left bracket of their utterances.

The (a) utterances of Tables 3 and 4 show modal-like items. Modal-*like*, as not all the items directly reflect TL use; thus Jasmijn's *handigniet* (handy not), for example, is idiosyncratic. Jasmijn's repertoire comprises two affirmative/negative oppositions: *kan vs. kanniet / wil vs. wilniet*, but affirmative equivalents for

Table 3. Early German (Valle 1;11, from Gretsch 2000)

	Pre-field	Left bracket: V_{FIN} ("V2")	Middle field	Right bracket: V_{INF} ("Vend")	Type
(a)	da *'there* *i* *'I*	dama *can* will *want*	da <sitz/ *there <seat/*	aufmachen *open'* sitz> *sit>*	modals*:* (+ *soll, muss*)
(b)	des *'this*	auchnoch *too-again*		rausmach *out-make'*	Particles of repetition
(c)	des *'this*	net *(is) not*	gummi *(a) rubber'*		*Nicht* (negation)
(d)	jetzt *'now* der bahnhof '*the station*	0 *0* is *is*	was *something* pät *late*	baun *build'* kommen *come'*	Implicit/ explicit assertion

Table 4. Early Dutch (Jasmijn 1;10-1, from Jordens 2002)

	Pre-field	Left bracket: V_{FIN} ("V2")	Middle field	Right bracket: V_{INF} ("Vend")	Type
(a)	Peter '*Peter* disse '*this*	moet *must* hoeniet obl-not		zitte *sit'* meeneme *with-take'*	modals*: kan* (*niet*) (ability*),* (*doe*) *maa* (please), *wil* (wish), *moet* (obl), *hoeniet* (obl not), *handigniet* (handy not)
(b)	Mijne '*Minje* Mijne '*Minje*	ook *also* zelf *self*		heppele *help'* doen *do'*	scope particles
(c)	poppie *'doll* dit '*this*	nee *no* nee *no*		ape *sleep'* afdoen *off-do'*	Negation
(d)	poesje *'kitty* Ruti *'Ruti* ik 'I	0 wél *indeed* doette *do(dim)*	vinger *finger* bad *bath*	bitje *bite'* zitte *sit'* opzitte *on-sit'*	Implicit/explicit assertion

hoeniet, handigniet are not attested. The (c) utterances illustrate the general form of negative utterances with the simple negator in the left bracket. Both children produce additive and restrictive scope particles – *auch, ook,* and others – in the left bracket of their utterances (b), to the exclusion of other items, just as Penner, Tracy and Weissenborn's, and Lasser's subjects mentioned above. The negator (c) shows similar behaviour. The (d) utterances show cases of implicit assertion, paralleled in the case of Dutch by use of the emphatic assertion markers *wél, doettie*. The fuller context of the *wél* utterance given in Table 4 (d) illustrates Jasmijn's command of contrastive assertion: *Ruti wél bad zitte, poppie NIET* ('R. can indeed sit in the bath [but] NOT dolly'). As well as implicit assertion, Tracy's (2005) data also attest 'placeholders' in the left bracket, for example: *ich [eee] hose maln* ('I [eee] trousers draw'). All the lexical verbs in the right bracket approximate closely to the TL infinitive pronunciation.

The constituent in the pre-field is often an expression referring to an entity which may or may not be the subject of a 'corresponding' TL utterance. Other expressions attested in this position are (deictic) adverbs of space or time. It is noticeable that if an expression other than the subject is in the pre-field, then the subject is left implicit (an observation due to Jordens 2002). Thus the (d) example of Valle from Table 3, repeated here:

(4) der bahnhof is pät kommen
('*the station is late come*')

occurs in a context where Valle sees a man miss his train. His mother reacts by saying "the station??" and Valle replies *nicht der bahnhof, der MANN* ('not the station, the MAN'): Valle's problem is apparently to find a position for 'the man' in his utterance. The omission of a contextually non-recoverable constituent reinforces the observation that the transition from Tracy's stage 1 to stage 2 is gradual: acquisition of the 'V2' rule is not instantaneous.[2]

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2. Some rare examples show on the contrary a 'V3' effect, with two non-verbal constituents in utterance initial position, i.e., there is no subject verb inversion in these examples either. In (i), a topical entity and time adverb occur before 'kann':

dann ich kann bum bum dann (Benny 2;09)
('*then I can boum boum then*')

In (ii), two expressions referring to topical entities occur before 'nee':

poesje die nee ete (Jasmijn)
('*pussy that no eat*')

A full discussion of the syntactic V2 acquisition process would take us too far afield, see Jordens (2002).

3.3 L1 utterances: French

The data set consists of the first 2 recordings of Grégoire from the CHILDES data base (MacWhinney & Snow 1985), made available by Christian Champaud. The recordings took place over a period of ten days, when Grégoire was aged between 1;9.18 and 1;9.28, with notes taken by Champaud on the days in between. These two recordings have been chosen because the morpho-syntax traditionally associated with finiteness is absent from them: the period is characterised by complete absence of 1st and 2nd person pronouns, and virtual absence of definite and indefinite articles. But we do find a demonstrative pronoun *ça*, and the timid beginnings of modal and auxiliary use. There are almost no morphological oppositions on lexical verbs: verbs of the first group end in the sound [e], which corresponds both to the infinitive and to the past participle pronunciation of TL French.

We do find however items which correspond to those described in the left bracket in the Dutch and German data. French utterances do not pattern like Dutch and German utterances: we will provisionally place these items in a

Table 5. Early French (Grégoire 1;9-10, from Jordens, Matsuo & Perdue, in prep.)

	A	**B**	**C**	**Post-field**	**Type**
(a)	singe '*(the) monkey*	[vœ] *want*	[mõte] *climb up*'		[vœ] modal
(b)	[əkok] '*(the) croco*	aussi *also*	dents *teeth*'		Scope particles
(c)	0 (*kleenex)* 0 *(maintenant?)*	[pa] [apy] *allgone*	propre *clean*' papa		[pa], [apy] negation
(d)	crocodile '*(the) croc* Pinpin '*Pinpin* là-bas '*over there* télé '*TV*	0 *is* 0 *(is a)* 0 *(is a)* 0 *(belongs to)*	joli *pretty*' lapin *rabbit*' voiture *car*' papa *daddy*'		Implicit (predicational, specificational, existential, possessive)
(d')	maman '*mummy* ça '*that* christian '*christian*	[E] [E] [ija]	beau *beautiful*' [mãze] *for food/to eat with*' cheveux *hair*'		[E], [ija] (predicational, specificational, existential, possessive)

column 'B', with column 'A' containing material which precedes them,[3] and column 'C' material which follows them (Grégoire's MLU at this age is 1,87, and there are virtually no utterances longer than three words).

We see in examples (a), (b), (c) a similar organisation to the Germanic utterances, although such examples are less prevalent in the French data (there are two occurrences of [voe] and one of [va] – AUX 'go' – in the data set). The (d) examples are however prevalent, and (implicitly) convey predicational, specificational, existential and possessive relations between their two constituents. These same relations are made explicit in the (d') examples of the table.

(d'): Investigator and transcriber both notice an element transcribed as [E], which occurs between the topic and the predicate. This element is very frequently commented on, as "its function seems dubious":

(5) *CHI: maman est beau ! <mummy is beautiful>
%pho: / mamã E bo ! /
%com: notice the e or E in in <mamã E bo>, its function seems still dubious

[e] corresponds to 'is', 'and' and 1st SING 'have' in written French. [e] is transcribed as *est* ('is') when the context would impose *est* on an adult speaker, in identificational and predicative sentences, amongst which we find resultative past participles. Thus, there are 20 tokens of *est* in Grégoire's first recording, 17 of which have either *tombé* 'fallen' or *cassé* 'broken' as the predicate.[4] Other items in the same context are transcribed [i(ja)] ('il (y) (a)'? 'there is'). These forms, and the relations they express, justify the parallel drawn between the (d) and the (d') utterances.

4. Summary and hypothesis

Tables 3–5 summarise the main regularities from the data sets. There are exceptions, but lack of space precludes their discussion, and the reader is referred to Jordens (2002) and Jordens, Matsuo and Perdue (in prep.). The items in the left

3. Ferdinand (1996), who analyses G.'s data from a generative perspective, notes the restriction that only one constituent is possible in pre-verbal position both at this stage and at a more advanced stage. Our analyses differ however in that Ferdinand restricts herself to utterances containing recognisable verbs, whereas we include predicates that can have other (simpler) structures than VP.

4. [voe] and [va] also combine with 'long' forms of the verb (ending in [-e]). All Grégoire's utterances are anchored in the *hic et nunc*, but allow the expression of prospective and resultative aspectual distinctions.

bracket, and column B, show remarkable similarities across languages and occur at a similar stage of development – 'between' Tracy's stage 1 and stage 2. We do therefore find a (limited) number of items with the same distribution as *auch,* at a stage where these items are in opposition with a finite verb form.

In his analysis of the functions of the finite verb form, Klein (1998) proposes the following example:

(6) 'the book WAS on the table'

where WAS is stressed. He observes that:

> WAS carries two distinct meaning components: 1. the tense component: it marks past, in contrast to present and future; 2. it marks the 'claim' – the fact that the situation described … indeed obtains, in contrast to the opposite claim. (1998: 227)

The finite verb form thus has a double function, one of which, in simple declarative sentences, is to assert that a situation indeed obtains at the time in question.

Jordens sums up his own findings thus:

> In early child grammar, elements of a closed-class category are used to express illocutionary force…. They can be adverb-like elements such as *nee* 'no', *handigniet* 'handy-not', and *niet* 'not', modalverb-like elements such as *kanniet* and *magwel*, and modal and scope particles such as *g(r)aag* 'please', *eve* 'just', *wél* 'indeed', *ook* 'too', *zelf* 'self '. In the case of simple assertion, the position … can even be left empty. (Jordens 2002: 744)

Returning to the original observation concerning *auch*, we see that its function at the relevant stage of development is indeed to convey illocutionary force. Nederstigt puts it thus:

(7) ***Auch** is an explicit marker of assertion*

> […] Caroline's particle use clearly reflects a conflict between AUCH and the finite verb. This conflict between the location of the particle and the finite verb provides evidence for the analysis of AUCH as an overt assertion marker because without this function the emergence of the finite verb in AUCH-utterances would be non-problematic. (Nederstigt 2002: 275)

As *auch* and the finite verb share the same function at this stage of development, they vie for the left bracket, and Nederstigt's term "conflict" is apt, as the following examples show:

(8) mann auch schlaf möchte (Penner et al. 2000)
(*'man also sleep wants'*)

(9) (Benny's mother brings coffee to the table)
ich AU will [fE:] / ich AU [fE:] will (Benny 2;02)
(*I too want coffee / I too coffee want*)

In (8), *möchte,* a TL finite form, is found in the right bracket of an utterance containing *auch*; and in (9), we see that Benny does not accept *auch* and a finite form both in the left bracket of his utterance, and self-corrects with a non-TL result of the finite *will* in the right bracket, too. We hypothesise then that, just as finite verb forms in simple assertive utterances, the *auch*-like items explicitly mark assertion, i.e., the utterances they occur in are semantically finite, and will briefly elaborate on this notion.

5. Towards a definition of semantic finiteness

Dimroth et al. (2003) analyse utterances at the stage of development that concerns us here as composed of three informational constituents, termed the 'topic', the 'predicate' and the 'link'. Table 6 shows the correspondences between the analyses of Tracy (2005), Nederstigt (2002), Perdue et al. (2002) used until now, with Dimroth et al.'s terminology.

Dimroth et al. further analyse Klein's "claim" – in enunciative terms, the utterer's commitment to the content of his utterance – into two operations: "grounding"[5] whereby the speaker establishes the topic (time, place, entity), and "validation" whereby the speaker asserts that[6] the predicate is valid for the topic. This latter function determines the class of non-verbal linking elements observed in the corpus. Thus:

Table 6. Terminological correspondences

Pre-field	**Left bracket: V_{FIN} ("V2")**	**Middle field**	**Right bracket: V_{INF} ("Vend")**
A	B	C	
Topic	Link	Predicate	

5. The term is used in a similar way to Maas (2004: 361): "semantical finiteness can be defined as the condition for an independent interpretation of a sentence. Thus semantical finiteness is related to the utterance and concerns…the mapping of the sentence onto the context of the utterance… this will be called the *grounding* of an utterance".

6. Or questions whether, etc. We limit the discussion to (variants of) assertion.

- *AUCH* (*ook, aussi*): functions to assert that the previous predicate is valid for the present (often contextually determined) topic.
- *ZELF* (NL): asserts that the predicate is valid for the present topic (to the exclusion of others).
- *auch/noch/nochmal* (*nog, encore*)*:* asserts that the previous topic (entity) – predicate relation is valid a second time.
- *wél* (NL): asserts that the predicate is indeed valid for the topic, contrary to the opposite claim.
- (stressed) *NICHT* (*NIET, PAS*): asserts that the predicate is not valid for the topic, contrary to the opposite claim. Or: that the present topic is not valid for the previous predicate.
- (unstressed) *nicht* (*etc.*): asserts that the predicate is not valid for the topic.
- And the absence of marker simply indicates that the predicate is valid for the topic.

To summarise the L1 data: Klein's analysis sees the finite verb as a carrier (1) of tense/person and also (2) of assertion, the claim that the predicate holds for the topic (time). We have seen that children start out with (2). Children thus separate out the two components, validating the descriptive content of an utterance in respect to its topic component *before* the stage where the grammatical categories traditionally associated with finiteness – (grammatical) person and tense – emerge on the finite verb. In Lasser's terms, the expression of S-finiteness is in place before M-finiteness is mastered.

6. Adult learners

In relation to finiteness, there are two obvious and important differences between child and adult learners of a language. Unlike the former, the latter have mastered the way that their L1 expresses S-finiteness and their learning task is (primarily[7]) to find new linguistic means to express this concept. And unlike the former, it is exceptional that adult acquirers[8] come to master the morpho-syntax of the new language. For Romance and Germanic L2s, finite verbal morphology and the associated syntactic operations are typically not mastered, and there is moreover great individual variation in the degree of mastery achieved. Klein and Perdue

7. "Primarily" because this statement is in fact a simplification. The adult may come to understand, e.g., L2 temporal distinctions not grammaticised in the L1. But this question takes us too far afield.

8. The discussion here is restricted to untutored language learners.

(1992) identified and described an initial stage of fossilisation[9] (the so-called 'basic variety') which they termed "infinite utterance organisation" (IUO) characterised by a mastery of the TL's verb-argument structure (VP), by a complete absence of inflexional morphology but by use of the (uninflected) copula. All of the forty longitudinal case studies analysed by Klein and Perdue exhibited this level, and one third of these learners did not progress further. For those learners who did, progress out of IUO started by use of inflected auxiliaries and modal verbs (see also Parodi 2000). Vainikka and Young-Scholten (1996) describe this development as VP > IP, and it is thus worth comparing the IUO stage (and initial developments from it) with the L1 data just examined.

Table 7 gives examples of utterances from learners at IUO, with a couple of examples of the first attested modals. The superficial similarity in organisation with the L1 utterances is striking, although there are major differences of content within each informational unit, attributable for our concerns to the adults' understanding of time in language: adults' utterances are less restricted to the here-and-now. For much detailed study of how adults make use of discourse organisation and an array of temporal adverbs to build complex temporal structures, the reader is referred to Dietrich, Klein and Noyau (1995) and Starren (2001) – space (sadly) precludes our going further into this here.

Table 7 shows an informationally more complex topic component than the child data, containing in particular anaphoric adverbs. In a subsequent study concentrating on use of additive scope particles *also, again* and translation equivalents, Benazzo, Dimroth, Perdue and Watorek (2004) found that young children use them to create links between extra-linguistic referents, whereas in adult use they could also refer anaphorically to topic expressions. The link column contains precisely those items found in the L1 data. As in the child data, the copula, and modals, when they appear, fit into the informational organisation of these simple utterances, and are uninflected. The [se] used by Hispanic learners of French (d') can be used with singular or plural topics and have present or past time reference. The utterance containing the modal *moet* ((a), repeated here as (10)), is found in a context which nicely illustrates this informational fit. The learner is retelling a dialogue in direct speech, where a policeman says "you must go to prison":

(10) jij moet *hapis* gaan

and the suspect replies "I am not going to prison":

(10') ik NIET *hapis* gaan

9. The term is from Selinker (1972) and can be summarised as an individual and permanent level of non-mastery.

Table 7. Adult L2 learners' utterances*

	Informant	Topic	Link	Predicate	Source
(a)	TD:ER	jij *'you*	moet *must*	*hapis* gaan *prison* go	Coenen & van Hout 1987
	PG:URZ	kind *'child*	will *want*	telefonieren *telephone'*	Dimroth et al. 2003
(b)	MF:ZA	Rachid *'R.*	encore *again*	mal le ventre *stomach ache'*	Starren 2001
	PG:IV	rote mann *'red man*	noch *again*	bier trinken *beer drink'*	Dimroth 2002
	TD:ER	daar *'there*	ook *also*	die man *that man'*	Dimroth et al. 2003
	PG:JA	jetzt mein bruder *'now my brother'*	auch *also*	zweiundzwanzig jahr *twenty-two year'*	Dimroth et al. 2003
(c)	IG:AN	mein kind *'my child*	nix *not*	in schul *in school'*	Becker 2005
	TD:MA	ik Ankara *'I Ankara*	niet *not*	school gaan Ramadan *school go ramadan'*	Starren 2001
	SF:PA	il *'he*	pas *not*	l'école *the school'*	Perdue et al. 2002
(d)	MF:ZA	toujours moi *'always me*		[fe] la cuisine ce soir *cook in the evening'*	Starren 2001
	TD:MA	en dan *'and then*		politie komen *police(man) come'*	Dimroth et al. 2003
	TD:MA	taxi *'taxi*	wél *indeed*	duur *expensive'*	Dimroth et al. 2003
(d')	SF:BE	après *'then*	[se] *is*	[lemarʃe] à pied *the/to walk on foot'*	Perdue et al. 2002
	SF:PA	côté *del* restaurant *'next to the restaurant*	[se] *is*	un kiosk *a kiosk'*	Perdue et al. 2002

* The first two letters in the "informant" column give the L1 and L2 of the learner: 'TD' indicates Turkish L1 and Dutch L2. Other L1s: P(olish), M(orrocan Arabic), I(talian), S(panish); other L2s G(erman), F(rench). The column "Predicate" shows verbs (e.g., *telefonieren* is the infinitival form 'to telephone'). The symbols ** enclose an L1 sequence, and [] a sequence in broad phonetic transcription.

NIET contrasts directly with *moet*, and (10') contains no finite verb.

It seems then that the adult learners of the languages examined here also start by using similar means to express semantic finiteness, but unlike children, do not necessarily go on to acquire morphological finiteness.

7. Discussion and conclusion

This paper has given an overview of analyses of the very first stages of utterance structure by learners of Dutch, French and German, L1 and L2. The analyses have shown a similar correspondence between the informational content of utterances, described in terms of 'topic, link, predicate', and the surface order of constituents for both types of learner and for all languages.

There are however obvious differences between the child and adult learners in the speed and success of the acquisition process. It takes the child some months at most to pass through the stages in question, whereas the adult can take much longer, or even fail to develop TL-like morpho-syntax. Whereas individual variation amongst adults is striking, variation between children should however not be underestimated. Most examples of Dutch and German L1 have been taken respectively from Jasmijn (1;10) and Valle (1;11), but the other children in Jordens' and Gretsch's studies – Andrea and Benny – only showed similar utterance organisation some months later, at 2;2-3.

Although the speed and success of the acquisition process varies greatly between learners, its structure is comparable. The results presented here are compatible with a structure-building view of the process and point to recognisable utterance-structure being in place before VP is mastered.[10] Nederstigt's sequence from section I (11a) can be reformulated in the light of our results as (11b), and compared with Tracy's sequence (11c):

(11) Structure of the acquisition process:

a.	Nederstigt (cf. §1)	AUCH	>	V_{INF}	>	V_{FIN}
b.	Reformulated as:	Lexeme	>	V_{INF}	>	V_{FIN}
c.	Tracy's (2005) sequence:			VP	>	IP

But these learner utterances have the pragmatics – not the syntax – of full, contextualised TL sentences, i.e., sentences dominated by CP. Is it then necessary to follow those authors cited in section I who advocate a full, albeit truncated, syntactic tree from the very beginning of the acquisition process? We have no convincing answer to this question, but would hesitate (see Section 2) to over-interpret learner utterances in the direction of corresponding TL utterances. It seems rather that the learning task is triple: first, work out some (perhaps learner-specific) means of expressing S-finiteness; then, work out the morpho-syntax of M-finiteness (optionally, if one is an adult learner: the very failure of some adults to master M-finiteness empirically reinforces the M-finiteness/S-finiteness

10. Corresponding to the "holistic stage" of Dimroth et al. (2003) or to the "nominal utterance organisation" of Klein & Perdue (1992).

distinction); and whilst doing so, work out how the two levels interlock. Evidence for this latter task is of course the conflict between *auch* and the finite verb which we started with (see examples (8) and (9)), and the concomitant difficulty learners of Germanic languages have in mastering V2.

In conclusion, we have seen that the learners studied, child and adult, first develop a small number of lexical 'link' items to validate the topic-predicate relation before this function is taken over by finite verb forms.[11] If the analyses presented here stand up to further scrutiny, they serve to qualify a widely accepted generalisation in acquisition studies, namely, that a fundamental difference between child and adult learners of (Romance and Germanic) languages is that the former, but not the latter, first develop, rapidly and effortlessly, verbal morphology and the associated syntax, what we have termed M-finiteness. And we have proposed further acquisitional evidence for the analytic distinction, established amongst others by Klein (1998) and Maas (2004), between M-finiteness and S-finiteness.

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PART III

Bilingualism and second language acquisition

A multidisciplinary perspective

CHAPTER 12

Age of onset in successive acquisition of bilingualism

Effects on grammatical development

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In first language acquisition, monolingual as well as bilingual, every child develops a full grammatical competence in the language s/he is exposed to. This is arguably not the case in second language acquisition (L2). My assumption here is that this is due to the fact that the Language Making Capacity which guides L1 development is not fully accessible any more to L2 learners. My claim is that it becomes inaccessible as a consequence of neural maturation, supporting thus the Critical Period Hypothesis. The latter should, however, be understood as a cluster of sensitive periods, each defined in terms of an optimal period for the development of specific features of grammar. Age of onset of acquisition is consequently argued to be the single most important factor distinguishing acquisition types. As for the age periods at which crucial changes happen, my claim is that they occur significantly earlier than is commonly assumed. More specifically, I will show that linguistic as well as neuropsychological evidence suggests that at least some aspects of grammar, relating to inflectional morphology and to syntax, are indeed affected as early as at age of onset between age 3 and 4. Further significant changes seem to happen at around age 6 to 7.

1. Introduction: The language making capacity

First language acquisition (L1) exhibits a number of characteristics which suggest that children are equipped with what can be qualified as a species-specific endowment for human language, including a language making capacity. Probably the most important observation is that every child develops a full grammatical competence in the language s/he is exposed to. Individual properties of children, like intelligence, personality, etc., and particularities of the acquisitional setting, e.g. social context, undoubtedly determine the linguistic skills of individuals, but, except in pathological cases, native speakers never fail to acquire the complete

set of structural properties underlying the utterances occurring in the ambient language. Importantly, exposure to the target language in interaction with mature speakers is sufficient for this achievement to become possible. Contrary to popular beliefs, grammar teaching or special coaching of such learners is not required; see Guasti (2002) for a state-of-the-art summary of research on L1 development.

L1 development, however, is not only characterized by the fact that it is always successful, a large body of research has demonstrated that the acquisition of core grammatical properties proceeds through strictly ordered developmental sequences. This is to say that the development of speech perception and production follows a specific trajectory, from the very beginning onwards, and once grammatical expressions appear in child language, they too emerge in a fixed order: if, for example, subject-verb and object-verb agreement are marked overtly in the target system, the former is used before the latter. Guasti (2002: Chapters 2–4) presents a summary of such findings, speaking of language 'growth' rather than 'learning', a commonly used metaphor in the theory of Universal Grammar (UG). In fact, UG is conceived as representing the initial state of the language faculty, i.e. as a theory about what the child brings to the task of language, prior to experience, and it is also thought of as a central part of the Language Acquisition Device (LAD). Chomsky (2000: 4) suggests we "think of the initial state as a 'language acquisition device' that takes experience as 'input' and gives language as an 'output' – an 'output' that is internally represented in the mind/brain." According to this view, UG is guiding language development, and this accounts to a large extent for the uniformity of development, across individuals and across languages.

Looking at second language acquisition (L2) from the same perspective, it is readily apparent that these two acquisition types do not share all of these characteristics; see Meisel (1991) for a discussion of the differences. Whereas L1 development happens relatively fast, the rate of L2 acquisition is typically protracted, and contrary to the uniformity of L1 across children, one finds a broad range of variation in L2, across individuals and within learners over time. Invariant developmental sequences, on the other hand, have been discovered for L2 as well, but they are not the same as in L1. Most importantly, perhaps, it is obviously not the case that all L2 learners are successful – on the contrary, L2 acquisition typically leads to incomplete grammatical knowledge, even after many years of exposure to the target language. Whether it is in principle possible to acquire native competence in the L2 is a matter of much controversy, but if it should be possible, the 'perfect' learners undoubtedly represent an extremely small fraction of those who begin L2 acquisition; see Abrahamsson & Hyltenstam (2009). The obvious question arising from observations like the ones alluded to is: What causes the differences between the two types of acquisition? More specifically, if UG can be

argued to explain the above mentioned characteristics of L1 development, does this imply that UG guides L1 but not L2 acquisition?

This question has been the object of a controversial debate in L2 research for more than 25 years, and I will not even attempt to summarize this discussion. Rather, in order to be able to dedicate more space to the main issue of the present paper, age of onset of acquisition, I will assume without further discussion that the observed differences are indeed of a fundamental nature, suggesting that the LAD which guides L1 development is not fully accessible to L2 learners. As for the further question of why this is the case, I adopt the maturation hypothesis according to which parts of UG are subject to constraints caused by neural maturation. As a consequence, age of onset (AO) is identified as the single most important factor distinguishing acquisition types. I will argue that, in spite of previously formulated objections, the Critical Period Hypothesis (CPH) first proposed by Penfield & Roberts (1959) can contribute significantly to an explanation of the phenomena under discussion, provided it is understood as comprising a set of sensitive periods affecting various grammatical phenomena at different points in development. The age period, however, during which crucial changes happen, will be claimed to occur significantly earlier than is commonly assumed. I will refer to some linguistic as well as neurological evidence which, I contend, support this claim.

2. Simultaneous and successive acquisition of bilingualism

Given the amount of research contrasting L2 with L1 acquisition, it must come as a surprise to find that only a tiny fraction of this literature is dedicated to the study of first languages in bi- or multilingual settings. Monolingual acquisition is clearly considered to be the "normal" case. The surprise stems from the fact that studies on multilingualism have produced a large and continuously increasing body of research offering strong evidence indicating that multilingual individuals are able to develop a competence for each of their languages, not substantially distinct from that of the respective monolinguals; see Meisel (2001, 2004) for state-of-the-art summaries of research on this issue. In fact, our species is the only one capable of acquiring not only language but more than one language. Comparisons of L1 and L2 should not fail to take such findings into account, if only because the most obvious way in which L1 differs from all types of multilingual acquisition is by the presence of another language in the environment and, more importantly, in the mind of the learner. If it could be shown that linguistic systems interact in the minds of learners, this fact would have to be regarded as a prime candidate as a

factor possibly influencing course and result of acquisition and therefore as being responsible for the observed L1–L2 differences.

In other words, a comparison of the various acquisition types may prove to be of crucial importance in the search for factors distinguishing L1 and L2 acquisition. Unfortunately, the by far most extensively studied comparison is the one opposing monolingual L1 to adult L2. This, however, confounds two variables, age of onset of acquisition and the presence of more than one language. In order to be able to disentangle these two potentially influential variables, it is necessary to include other types of acquisition. If the goal is to assess the importance of cross-linguistic influence, *simultaneous* development of two languages (2L1) should be compared to *monolingual* L1, but also to *successive* acquisition of languages which can inform us about the role of *previously* acquired knowledge. And when it comes to learning about the role of age and maturation in acquisition, the goal in the present paper, the discussion cannot be limited to a comparison of adult L2 with L1, bilingual or monolingual, for that matter. We also need to take into account the changes which become manifest in *successive* language acquisition during *childhood* and the way in which they affect subsequent language acquisition.

2.1 Simultaneous acquisition of two or more languages

As should have become apparent from the previous remarks, the simultaneous acquisition of languages represents an essential point of reference when attempting to assess the relative importance of factors determining the various types of acquisition. With respect to the current discussion, the crucial finding of previous research on children acquiring two or more languages from birth is that it qualifies as a case of multiple first language acquisition; see de Houwer (1995) for a summary of these research results. This conclusion is primarily based on the following observations: (1) linguistic systems are differentiated early on, (2) grammatical development proceeds through the same developmental sequences as in monolingual acquisition, and (3) grammatical knowledge ultimately attained in each of the languages of multilingual children is identical in nature to that of their monolingual counterparts. The latter two are, of course, immediately reminiscent of the defining properties of monolingual L1 development, mentioned at the beginning of this paper, uniformity and ultimate success of grammatical development. These findings therefore confirm the claim that simultaneous acquisition of bilingualism is a type of L1 acquisition. As a consequence, just as in L1, these properties of 2L1 can be attributed to the availability of the LAD; i.e. bilingual as well as monolingual L1 acquisition is guided by principles of UG.

Note that the first observation, the thoroughly studied early differentiation of grammatical systems, can be regarded as a necessary prerequisite for the other two, and thus for the qualitative non-distinctness of 2L1 as compared to L1. This is because the precocious differentiation of grammars avoids the necessity of 'resetting' parameters inappropriately set to a non-target value – an arguably impossible task. The fact that the Differentiation Hypothesis has been confirmed by numerous studies investigating a large variety of language pairs is therefore of considerable importance; see Meisel (2001, 2004) for summaries of the relevant research. It demonstrates that these bilinguals (i) distinguish functionally between their languages as early as around age 1;10; (ii) develop distinct grammatical properties in the respective languages before age 2;0, having barely reached an MLU (Mean Length of Utterances) value of approximately 2.0; (iii) pattern with their monolingual peers in developing grammatically distinct but superficially equivalent expressions differently in their languages, as required by target systems.

Let me add that the question of whether subsequent development, once grammars are differentiated, proceeds autonomously or whether it exhibits effects of cross-linguistic interaction, represents a somewhat more controversial issue in current research. But to my knowledge, possible cross-linguistic influence does not result in qualitative alterations of language development (Meisel 2007), i.e. it does not, for example, affect otherwise invariant order of phases in developmental sequences. Rather, it appears to lead to quantitative effects, e.g. over- or underuse of specific forms or constructions, and it has only been detected in *some* children and in *some* contexts for any given individual. In other words, possible interdependent developments do not oblige us to revise the claim that simultaneous acquisition of languages qualifies as a case of multiple L1 development.

As a preliminary conclusion one can thus state that the presence of another language is not a factor causing substantive differences between this acquisition type and monolingual L1 development – at least not when languages are acquired simultaneously.

2.2 Successive acquisition of bilingualism: The Fundamental Difference Hypothesis

This brings me to the problem of how successive acquisition of bilingualism differs from both monolingual and bilingual L1 development. Investigating the question of whether maturational changes cause differences between types of acquisition quite obviously only makes sense if (2)L1 and L2 are indeed different. As mentioned in the previous section of this paper, the claim that differences between L1 and (adult) L2 do exist is not controversial in L2 research. In fact, it

is generally agreed that they relate to rate and uniformity of acquisition as well as to the course and ultimate success of the developmental process.

Yet L2 researchers do disagree on whether such differences reflect substantive changes in the learner, as is argued by the Fundamental Difference Hypothesis (FDH) according to which UG as the centerpiece of the language making capacity is not fully accessible anymore in L2 acquisition; see Bley-Vroman (1990) among others. Alternatively, it has been claimed that the LAD remains completely accessible (UG Hypothesis) and that, consequently, the observed differences can not be due to changes in the capacities of the learners. Instead, differences between these types of acquisition would have to be explained in terms of secondary factors influencing the course of acquisition. One possible factor of this sort stems from the widely acknowledged fact that the starting points, the knowledge systems available to the learners at the initial state, are quite different in the two cases. It is, indeed, hardly possible to doubt that previously acquired knowledge shapes the initial state in L2. Empirically, this means that early L2 utterances tend to be longer and probably more complex, as compared to early instances of L1 speech, and they contain functional elements which are typically lacking in early (2)L1 language; see Grondin & White (1996) or Parodi (1998), among others. Thus, even if the LAD was fully accessible to L2 learners, they will necessarily follow distinct developmental paths, at least temporarily, given the different points of departure. This observation calls for a study of the role of previously acquired knowledge in order to distinguish its effects from those exerted by maturational changes. Comparisons between adult and late child L2 acquisition with very early successive acquisition during the first three years of life might shed some light on this problem.

But this is not really the crucial issue at stake here. This hinges instead on the question of the nature of the influence exerted by previously acquired on subsequently learned languages, i.e. on whether one postulates substantial transfer of knowledge, or whether the influence is understood as happening in a more subtle way, e.g. via L1 parsing strategies; see Carroll (2001). According to the Full Transfer/Full Access hypothesis proposed by Schwartz & Sprouse (1996: 40f.) "the initial state of L2 acquisition is the final state of L1 acquisition … excluding the phonetic matrices of lexical/morphological items". This hypothesis and similar scenarios thus predict massive transfer of grammatical knowledge from the L1, resulting in radical differences between L1 and L2 acquisition at the initial state. In terms of parameter theory, this entails the necessity of 'resetting' parameters for which the two target systems require different settings and which are initially set in L2 to the L1 value. This, however, may not be possible for principled reasons, as has been argued by Clahsen (1991), Müller (1994) and others. Remember

that in the simultaneous acquisition of bilingualism this problem is avoided by the early differentiation of grammatical systems, as mentioned above.

To avoid misunderstanding, it is undoubtedly possible to learn the various surface phenomena related to a specific parameter setting. Yet my claim is that learning in this case is not an instance of parameter setting. In other words, the problem is not whether it is possible for (some) L2 learners to acquire a near-native proficiency in using certain L2 patterns – this is trivially possible – it concerns rather the nature of the underlying linguistic knowledge and the role of UG in the process of its acquisition. Claims to the effect that parameter values have been 'reset' remain vacuous unless proponents of the UG Hypothesis provide empirically testable evidence distinguishing parameter 'resetting' from inductive learning. As far as I can see, this remains to be done; see Meisel (1998).

But such a broad issue cannot, of course, be dealt with adequately within the limits of a single paper, and these remarks are merely meant to justify the Fundamental Difference Hypothesis. Note that the FDH and, in fact, the theory of UG more generally, presuppose a modular view on the human mind. Moreover, adopting the FDH does not mean that access to UG is necessarily ruled out altogether, but it does entail the rejection of the claim of 'full access' to UG in L2 acquisition. An interesting specification of the basic assumption of the FDH, first proposed by Towell & Hawkins (1994) and by Smith & Tsimpli (1995), states that only parameterized principles are concerned when fundamental differences between L1 and L2 acquisition emerge; a similar view is held by Eubank & Gregg (1999). In fact, Smith & Tsimpli (1995) find evidence enabling them to argue that only parameterized principles are subject to maturation. This is of particular importance, for it establishes a relationship between linguistic and neural maturation, emphasizing the modular organization of mind and grammar. From this perspective, it is more plausible to hypothesize, I believe, that parameterized principles become inaccessible, rather than merely "progressively resistant to resetting" (Towell & Hawkins 1994: 126). The claim, in other words, is that L2 learners do not have direct access to options provided by parameterized UG principles; see Meisel (2000) for a more detailed discussion. Thus, although they can make use of previously acquired grammatical knowledge, they cannot fix the value of a parameter not instantiated in L1, and they cannot 'reset' those parameter values in which the two grammars differ. Instead, they have to make use of other cognitive resources in order to compensate for those not available anymore. This means that they may have to rely on inductive learning where triggering of implicit knowledge has become impossible. Non-parameterized principles of UG, on the other hand, constrain L2 acquisition in essentially the same way as in (2)L1. Consequently, L2 knowledge conforms only in part to principles of UG, whereas other parts are not

constrained by domain-specific cognitive principles but are the result of domain-general operations. In this sense, L2 knowledge is a *hybrid* system.

Let me emphasize that this claim relies on the assumption that human cognition comprises a language-specific module, characterized by, among other things, domain-specific operations and a developmental schedule largely independent of the development of domain-general cognitive mechanisms – contrary to what a Piagetian approach to language acquisition might predict; see Felix (1987) for an illuminating discussion of this issue. In fact, this is a major reason for why adult L2 learners are *not* more successful language learners than L1 children, in spite of their fully developed cognitive capacities and skills. As pointed out by one of the reviewers, the cognitive immaturity of 4–7 as well as 8–12 year old child L2 learners (see below) might distinguish these two groups from each other and from adult L2 learners. This, of course, applies only to those linguistic domains where child and adult L2 learners rely on domain-general operations. Note that it has been observed repeatedly (see Long 1990, for a discussion of these findings) that older child L2 learners appear to have temporary advantages over younger ones in some domains like the learning of the inventories of morphological forms. This could be interpreted as evidence supporting the predicted differences between L2 learners at various ages. I will return to the issue of child L2 acquisition immediately.

To sum up very briefly, the Fundamental Difference Hypothesis, as I interpret it, enables us to make specific claims about the grammatical domains in which L2 is expected to differ from (2)L1. Moreover, it identifies maturational changes in the individual as the major cause for these differences. Remember that findings from research on 2L1 development led to the conclusion that the presence of another language cannot be regarded as a sufficient cause for these facts. We may draw a different conclusion when languages are acquired successively. But to the extent that this is indeed the case, it must be kept in mind that in simultaneous language acquisition differentiation of grammars is achieved early and without apparent effort, whereas recovering from target deviant initial states in L2 is much less successful, if at all possible. This confirms the suspicion that age of onset of acquisition plays a crucial role in distinguishing these acquisitional types.

In what follows, I will first attempt to clarify the idea that the Language Making Capacity undergoes substantive changes during a period of maturation, and I will then cite linguistic as well as neuropsychological evidence indicating that sensitive periods of grammatical development end earlier than is commonly assumed.

3. Sensitive periods in language development

Postulating a causal relationship between maturational changes and changes in the language acquisition capacity is of course not a novel idea, but one which resumes claims made by the Critical Period Hypothesis (CPH), suggested by Penfield & Roberts (1959). Due to the seminal work by Lenneberg (1967), it also gained much attention in the language sciences, and although he was mainly concerned with the development of a first language, Lenneberg (1967: 176) extended it to L2 acquisition.

> … automatic acquisition from mere exposure to a given language seems to disappear [after puberty], and foreign languages have to be taught and learned through a conscious and labored effort. Foreign accents cannot be overcome easily after puberty. However, a person *can* learn to communicate at the age of forty. This does not trouble our basic hypothesis.

Subsequent research has demonstrated that the original hypothesis needs to be revised in a number of important aspects, e.g. with respect to the alleged causal role of lateralization in this process and, more importantly for the present discussion, the originally suggested age range; see Long (1990) and Hyltenstam & Abrahamsson (2003) for state-of-the-art discussions from an acquisition research perspective. These revisions do not however affect the fundamental concept of the CPH, and it ought to surprise us that it has met with much skepticism among L2 researchers, as is evidenced, for example, by some of the contributions to the volume edited by Birdsong (1999). Some of the criticisms directed against the CPH and certainly the conflicting results of empirical studies result from an insufficiently precise definition of the CPH, as has been noted by Eubank & Gregg (1999) and from the fact that in its common conceptualization it actually covers several hypotheses, as Birdsong (1999) correctly observed.

In order to avoid this fallacy, it is necessary to define the critical period more strictly. First of all, it must be kept in mind that it is not 'language' which is affected by changes but certain *domains of grammar*. Lexical knowledge, for example, is not predicted to be concerned at all. Secondly, it is not reasonable to expect that all grammatical domains will be affected simultaneously, during a single age period. Past research rather suggests that the subcomponents of grammar – syntax, phonology, and morphology – do not follow the same developmental agenda; see Eubank & Gregg (1999). In fact, even within these subcomponents one should expect to find asynchronous developments, tied to fairly specific grammatical phenomena. Consequently, the critical period is better understood as a *cluster of sensitive phases* during which the LAD is optimally prepared to integrate new information into developing grammars.

One of the most difficult issues related to this problem concerns the *age range* during which crucial changes happen. I refer again to Hyltenstam & Abrahamsson (2003) for a careful and thorough discussion of this topic. As should already be apparent from the remarks above, we are dealing with multiple sensitive periods which are, moreover, subject to individual variation. In addition, notions like 'critical period' or 'sensitive phase' do not imply abrupt changes, as if the capacity in question was switched on/off. Rather, we may assume that after a relatively short onset, each phase is characterized by an optimal period, followed by a gradual offset. In view of these considerations, it should be obvious that the age range of a Critical Period for successive language acquisition can only be determined tentatively, aiming at an approximate time period during which several sensitive phases related to a particular grammatical domain cluster, referring for each of the phases to the end of the optimal period, i.e. the time when an optimal period begins to fade out.

Hyltenstam & Abrahamsson (2003: 575) conclude that "At least up to AOs [ages of onset, JMM] 6 or 7, all learners will automatically reach levels that allow them to pass as native speakers – provided that there is sufficient input and that the learning circumstances are not deficient." Judging on the basis of the evidence presented, this seems to be an optimistic but perhaps not impossible conclusion, and the ages of onset are roughly in line with what Long (1990) suggested. After this age, social-psychological factors play an increasingly important role in L2 acquisition, whereas their influence is negligible during early childhood. In other words, although the kind of knowledge attainable in successive language acquisition does not depend on a single factor, maturation plays the crucial part during the first years of childhood. In fact, Hyltenstam & Abrahamsson (2003: 570) "suggest that maturational effects can be detected much earlier, perhaps as early as 12 months" referring to phonological development, and they observe that maturational effects on language development are noticeable as of birth and up to approximately age 15, the moment when, according to them, the maturational period ends.

The picture of successive language acquisition which becomes visible in the light of this report on the state-of-the-art of relevant research shows us that native-like grammatical knowledge may never be attainable in this case, cf. Abrahamsson & Hyltenstam (2009), although the differences, as compared to native speakers, will be subtle and confined to some aspects of grammar if the age of onset of acquisition occurs during early childhood. Moreover, I think we can say that changes do not happen in a continuous fashion over the entire maturational period. Rather, certain aspects of grammar are affected in a more decisive way during specific age periods.

In order to be able to put such hypotheses to a test, it is necessary to commit oneself to fairly precise age ranges, even if these are necessarily tentative

approximations. With this caveat, I want to suggest age ranges which appear to be crucial for the development of morpho-syntax, the component of grammar I am primarily concerned with. Noticeable differences as compared to L1 development emerge, I contend, as early as age of onset between 3 and 4 years, and I will thus refer to successive acquisition with first exposure to the second language after this age as child second language acquisition (cL2). Prior to this age range, I will assume that we can speak of simultaneous L1 development (2L1), although further research may very well reveal that differences emerge already at this early age. If age of onset happens after the above mentioned age of approximately 6–7 years, I will refer to this type of acquisition as adult L2 (aL2), even if one can undoubtedly detect differences between learners, depending on whether their first exposure to the L2 occurred earlier or later after this age.

Tentative age ranges
2L1 ≤ 3
cL2 ≥ 4
aL2 ≥ 8

Although defining exact age ranges is still a matter of speculation, there can hardly be any doubt that the optimal periods for grammatical development occur significantly earlier than is commonly assumed, following Lenneberg's (1967) idea that the age around puberty was the crucial one. Incidentally, McLaughlin (1978) already set the cut-off point between first and second language acquisition at age 3, and although he viewed this as an arbitrary decision, it was based on (limited) empirical evidence. Still today, successive acquisition with AO before age 8 is seriously underresearched. As for the first three years, research is extremely scarce, and only very recently have researchers begun to pay more attention to AO between age 3 and 6. In what follows, I nevertheless hope to be able to present some linguistic as well as neuropsychological evidence lending support to the age ranges proposed here.

4. Child L2 acquisition: Linguistic evidence

In the preceding sections of this paper, I have argued that both bilingual and monolingual development differ in clearly observable ways from second language acquisition, and I adopted a version of the Fundamental Differences Hypothesis which accounts for these differences in terms of maturational changes affecting specific domains of grammar. Evidence supporting this approach, is, however, primarily based on comparisons between L1 and adult L2 acquisition. By distinguishing between cL2 and aL2 as defined in the preceding section, I am making the

further claim that child learners whose first exposure to another language occurs at around or after age 4, share some of the properties particular to L2 acquisition with adult learners. Note that I remain neutral concerning the question of whether they can ultimately attain native knowledge. Note further that my claim is not that the language of cL2 learners is identical in all respects to that of aL2 learners. After all, even aL2 learners do not differ in every respect from (2)L1 children, and it is only reasonable to predict similarities between cL2 and (2)L1, as well. But if my hypothesis is correct, we should find core properties of grammar in which cL2 learners resemble aL2 learners but which are not attested in (2)L1. In what follows, I will briefly refer to some studies on child L2 acquisition. For reasons of space, this has to be a selection of works, rather than an exhaustive summary; see Unsworth (2005) for a more comprehensive review of work on cL2.

One of the early studies investigating L2 grammatical acquisition by children is the one by Pienemann (1981), analyzing the L2 German of two Italian children, AO approximately 8 years. This longitudinal study over 60 weeks focused on various aspects of grammar, including German word order, arriving at the conclusion that grammatical acquisition in these children resembled adult L2 acquisition of German in all relevant aspects. Importantly, they proceeded through the same developmental sequence as the aL2 learners studied by Meisel, Clahsen & Pienemann (1981), although their acquisition rate tended to be faster than that of the adults. This can be taken as one important piece of evidence supporting the claim that L2 acquisition as of age 8 (AO) is indeed essentially similar to aL2 with respect to a number of cases involving parameterized principles.

Another particularly interesting study is the one by Hyltenstam (1992) who focused on the age range around age 6, i.e. towards the end of what I have classified as cL2. He analyzed 24 adolescent high proficiency learners of Swedish, 12 Spanish and 12 Finnish L1 speakers, plus 12 native speakers of Swedish as a control group. For 16 of the learners, AO was below 6 years, for 8 of them at or above 7 years of age. Differences in error rate between each of the bilingual groups and the monolingual group were statistically significant, but not the difference between the two bilingual groups and the monolingual group. Note that certain types of errors are only attested among L2 learners, e.g. failure to place finite verbs in clause-second position (*V3), or non-target use of tense and of gender agreement, all arguably reflecting parameterized differences between the respective L1 and Swedish as L2. Importantly, grouping learners by error rate revealed that late AO learners are all assigned to the group with higher error frequencies, whereas the learners with earlier AO behave in a more heterogeneous way. Hyltenstam concludes that AO is a necessary but not sufficient requirement for near-native ultimate attainment. However, these findings are also compatible with a different interpretation. If, namely, the age ranges suggested do reflect periods of change,

the group with AO at 6 years or earlier is in fact a heterogeneous one because it comprises cL2 as well as 2L1 children. In other words, the results obtained by Hyltenstam are not necessarily in conflict with the hypothesis postulating changes at around age 4 – they might indeed provide indirect evidence in its support.

It thus seems that empirical evidence can be found supporting the claim that the age period around 7 years defines a possible cut-off point and that different types of L2 learners share a number of grammatical properties which distinguish them from (2)L1 children. But although it is also possible to cite studies reporting on changes in the knowledge of learners at earlier ages, it remains to be seen whether this justifies the hypothesized distinction between L1 and L2 acquisition and whether this happens indeed as early as between 3 and 4 years of age.

Schwartz (2004) in fact refers to the age range from 4 to 7 as child L2 acquisition, but she understands cL2 as bridging a gap between L1 and aL2 acquisition, and although she does not explicitly address the issue of neural or cognitive maturation, she sees cL2 learners as "arguably cognitively closer to L1 children than to L2 adults" (Schwartz 2004: 99). Assuming that this statement is meant to apply to grammatical development, it does not become evident how it can be justified. In her comparison of L1 and L2 acquisition she distinguishes rightly between ultimate attainment and course of acquisition, and between syntax and morphology. With respect to ultimate attainment, she finds that there are differences between the L1 child and (at least) the L2 adult. Looking at course of development, she states that child L2 acquisition is like adult L2 acquisition (and both are distinct from child L1 acquisition) *in the domain of syntax*, but that child L2 acquisition is like L1 acquisition (and distinct from adult L2 acquisition) *in the domain of inflectional morphology*. This certainly comes as a surprise since even the cursory review of some cL2 studies presented here suggests strongly that cL2 patterns with aL2 in at least some areas of inflectional morphology (tense, agreement) as well as in the use of word order. In fact, inflectional morphology seems to offer more problems for these children than most aspects of syntax. This, however, is an empirical question which will hopefully be answered by future research. At this point, I propose a tentative answer, based on the first results of an ongoing research project.

This study contrasts simultaneous acquisition of French and German with successive acquisition of French by children first exposed to this language when entering the *Lycée Français de Hambourg* at around age 3. It consists of a cross-sectional pilot study, previously analyzed by Loewe (2004) and Stöber (2004), and a quasi-longitudinal study, recording children at 3–6 month intervals over a period of two years, see Meisel (2008). The focus is on the development of finite verb forms. As has been mentioned above, French agreement is acquired before tense by (2)L1 children (Meisel 1994). Importantly, errors in person agreement

are typically not found. In Colloquial French, subject clitic (SCL) pronouns can be analyzed as agreement markers; see Kaiser (1994) and more recently Bonnesen & Meisel (2005). Irrespective of the details of this analysis, what matters is that these elements enter into a close relationship with the finite verb.

Interestingly, the *cross-sectional* study revealed that verb inflection causes problems for most of the cL2 learners studied, even after six years of exposure, i.e. they occasionally use non-finite verb forms in contexts where finite forms are required. In contrast, only a single error of this type is attested in the recordings with the 2L1 children. This represents a first difference between cL2 and (2)L1 learners. Note that the L2 children pattern in this respect with adult L2 learners; see Parodi (1998). Even more revealing is the fact that cL2 learners occasionally combine SCL with non-finite verb forms, an error not found in the data of the (2)L1 children, neither in this corpus nor in other published corpora. The *longitudinal* study examined the speech of children whose ages of onset in acquiring French ranged from ages 2;11 through 3;07 and who had been exposed to this language for 5 months (group A), 1;04 (1 year and 4 months, group B), and 2;04 (group C). Children in group A did not yet use finite verb forms productively. As for those in groups B and C (five each), they exhibited considerable variation across individuals in that productive use of finiteness has not been acquired by two children in group B and by one in C. Another potentially relevant observation is that three of the children in group B used constructions combining two finite verbs, a pattern not attested in (2)L1 development. Most importantly, however, 3 out of 5 children in each group occasionally combined SCL with non-finite verbs, i.e. they share this property distinguishing them from (2)L1 children with the learners studied cross-sectionally.

What matters for the present discussion is that the SCL + nonfinite V pattern not only makes cL2 look different from (2)L1, it also brings it closer to aL2 since this construction is known to be used by adult L2 learners of French; see Granfeldt & Schlyter (2004). They contrast the acquisition of French SCL, OCL (object clitics) and determiners, all three analyzed as clitic elements, by adult Swedish learners with the development of these elements in Swedish-French bilinguals. According to their analysis, adult L2 learners do not cliticize pronominal subjects and objects; rather, they treat pronouns as arguments (XPs) at spell-out, whereas 2L1 children treat them as X^0–heads from early on. This analysis is supported by a number of word order properties. Full NP subjects, for example, need not be placed adjacent to the verb, they initially tend to appear in clause-final position. SCL, on the other hand, are never separated from the finite verb. In aL2 acquisition, however, SCL are stressed and can be separated from the verb, clitic doubling is extremely rare, and NP subjects are consistently placed in preverbal position. Similar differences are reported to exist in the grammar of

object clitics. It is not until a fairly advanced phase of L2 acquisition that cliticization becomes possible.

These preliminary results thus suggest that, contrary to Schwartz (2004), it is precisely in the morphological domain in which cL2 resembles aL2 and where it is distinct from (2)L1, a conclusion which is supported by the analysis of the acquisition of grammatical gender by these children, see Meisel (2009). As for word order, Loewe (2004) concluded that the cross-sectional data do not provide evidence of problems of this sort. This is also true for the longitudinal study, but these data are not sufficient to exclude this possibility. In other words, although I did not find evidence supporting the claim by Schwartz that child L2 acquisition is like adult L2 acquisition and distinct from child L1 in the domain of syntax, this possibility cannot be ruled out on the basis of these data. In fact, a recent study by Sopata (2008) of three Polish boys learning German (AO 3;8–4;7) demonstrated that German OV order is not the preferred pattern and that they initially place finite verbs frequently in a target-deviant *V3 position, while at the same time moving non-finite verbs to the V2 position, an unambiguous feature of L2 acquisition.

In sum, although I certainly do not pretend to have presented conclusive evidence, I hope to have shown that substantive evidence can be adduced supporting the claim that the nature of grammatical knowledge acquired in successive language acquisition differs according to age of onset of acquisition, the age periods between 3–4 and 6–7 being of particular importance, in this respect. Furthermore, I believe to have shown that one can find empirical support for the hypothesis that cL2 shares crucial properties with aL2, distinguishing both from (2)L1. The grammatical features in which cL2 resembles aL2 undoubtedly include examples from inflectional morphology, but possibly also aspects of syntax. A more precise and theoretically motivated definition of the grammatical domains affected by maturational change is still lacking.

5. Child L2 acquisition: Neuropsychological evidence

In this paper, I have argued that successive acquisition of languages results in substantive differences with respect to the course of development as well as concerning crucial properties of grammatical knowledge when compared to simultaneous acquisition of languages or to monolingual development. Age of onset of acquisition has been claimed to be the major cause of such differences, primarily due to neural maturation. It is because of the neural aspect that an argument of this type cannot be limited to a discussion of the grammatical implications of the hypothesis defended here. Rather, it is necessary to indicate what kind of evidence

supports the claim that changes in the functional organization of the brain are largely responsible for the differences observed between various types of learner languages. Although, for reasons of space, this can only be done in a cursory fashion, referring briefly to neuroimaging studies should suffice to confirm the well-foundedness of the line of argument developed in this paper. In fact, this type of evidence enables us to draw a clearer picture of developmental changes and sensitive periods than the one emerging from linguistic studies, for in behavioral data, effects of maturational changes can be 'masked' (see Eubank & Gregg 1999: 82) if learners resort to non-domain-specific operations.

Neuroimaging studies start from the idea that changes in the functional organization of the brain over time should result in different activation patterns as well as in a different spatial organization of the brain in language processing if the onset of exposure to a language does not fall within the optimal period, whereas no such differences are expected to emerge if first exposure to a language falls within this period. Supporting evidence for this assumption has indeed become available over the past years through studies using electrophysiological as well as various haemodynamic methods (e.g. functional magnetic resonance imaging, fMRI, or positron emission tomography, PET). It should be noted, however, that most of these investigations focus on comparisons between L2 and monolingual L1 acquisition; very few include bilinguals who have acquired both their languages from birth.

These remarks primarily concern activation in areas of the brain which are typically involved in language processing, most importantly Broca's area (Brodmann area (BA 44–45) and Wernicke's area (BA 22)); see Friederici (2002). In the present context, Broca's area, encompassing the pars opercularis of the left inferior frontal gyrus (BA 44) and the posterior portion of *pars triangularis* (BA 45), is particularly relevant, for it is assumed to play a crucial role in syntactic processing during sentence comprehension.

Electrophysiological research uses electroencephalography (EEG), a non-invasive method by which electrical variations induced by neural activity are recorded at the surface of the scalp. From these recorded variations event-related brain potentials (ERPs) are derived. EEG makes it possible to locate electrical activity of the brain in different critical regions, even if the major advantage of ERP studies is their high temporal resolution whereas they do not reach the higher spatial resolution of haemodynamic methods.

A number of ERP studies, e.g. Weber-Fox & Neville (1996, 1999), demonstrated that the *spatial* distribution of activation patterns in the left hemisphere changes at later ages of onset of acquisition, i.e. specialization in the left hemisphere is reduced, and the right hemisphere is increasingly activated. The critical age range seems to be at around age 4;0 years and again around 7 years, i.e. if age

of onset happens at age 4 or later, this effect of more diffuse spatial distribution and increasing right hemispheric processing becomes increasingly stronger. Importantly, Weber-Fox & Neville (1999) and others observed not only differences in spatial distribution but also in the *quality* of ERP-responses as a result of later ages of onset. The most crucial finding is that such differences between L1 and L2 learners are only detectable if subjects are exposed to syntactically deviant sentences, whereas exposure to semantically ill-formed ones does not produce this type of effect. Weber-Fox & Neville (1999: 35) concluded that "later learners utilize altered neural systems and processing of English syntax".

A functional dissociation within the neural basis of auditory sentence processing has, in fact, been observed in a number of ERP studies; see Friederici (2002) for a critical review and for an outline of a 'syntax-first model' of processing. Hahne & Friederici (2001), for example, report, as do Weber-Fox & Neville, that first and second language learners differ primarily in their processing of syntax. In native speakers, semantic processes are reflected in a centro-posterior bilateral negativity between 300 and 500 ms, the so-called N400. Syntactic processing is correlated with two ERP components, a left-anterior-negativity (LAN), which occurs early, between 100–500 ms, and a later centro-parietal positivity, P600, between 500–1000 ms. The subjects of this study, Japanese speakers who had learned German as adults, were exposed to grammatical and ungrammatical as well as semantically correct and deviant German sentences. No differences between L1 and L2 learners could be detected with respect to semantically ill-formed stimuli, i.e. both evidenced the N400 effect. In processing grammatical and ungrammatical stimuli, however, the activation pattern of L2 learners are clearly distinct from those of L1 speakers in that neither early LAN nor P600 effects could be detected in the L2 learners. This can be interpreted as indicating that formal, syntactic aspects of language are subject to maturational changes; see also Isel (2005) for a review of ERP studies investigating L1 and L2 acquisition.

Studies using haemodynamic methods of investigation corroborate these results. They find differences with respect to spatial differentiation as well as intensity of brain activation between native speakers and L2 learners, and this refers again to morpho-syntactic, not to semantic or pragmatic processing. In functional magnetic resonance imaging (fMRI), variations of cerebral activity are recorded as tomograms, i.e. slices through the brain measuring the regional cerebral blood flow (rCBF). This, in turn, is interpreted as reflecting regional brain activation.

Kim, Relkin, Lee & Hirsh (1997) contrasted in their fMRI study six children acquiring two languages from "early infancy" with six bilingual children who acquired their languages successively (11;2 average age of onset). They find that in early bilinguals both languages are processed in largely overlapping regions in

Broca's area, whereas in successive bilingualism processing of the two languages is spatially separated.

Also in an fMRI study, Dehaene, Dupoux, Mehler, Cohen, Paulescu, Perani, van de Moortele, Lehérecy & Le Bihan (1997) find that processing of L2 relies on larger and spatially more diffuse networks than of L1, and they conclude that "... first language acquisition relies on a dedicated left-hemispheric cerebral network, while late second language acquisition is not necessarily associated with a reproducible biological substrate." The authors report on more brain activation in the temporal lobe and in the right hemisphere and generally more individual variation in L2-learners when compared to native speakers.

It must be noted that these studies have been criticized for methodological shortcomings. Since 'stories' were played to the subjects, or they had to produce 'inner language', there is virtually no control of the stimulus material or of the elicited mental activity. It is therefore difficult to determine whether group differences are due to AO or to differences in the stimuli or the mental activity. Another weakness is that either these studies did not consider the possibility that proficiency in a particular language might be the cause of observed neurolinguistic differences between groups, or they did not assess the linguistic proficiency of the learners adequately. Despite these problems, we cannot ignore the fact that these investigations suggest quite strongly differences depending on age of onset of acquisition of the respective languages. More importantly, crucial aspects of the results obtained by these studies have been corroborated by recent fMRI investigations.

Wartenburger, Heekeren, Abutalebi, Cappa, Villringer & Perani (2003) also elicited brain responses to syntactically and semantically well-formed and ill-formed sentences. They too find that brain activities depend on age of onset of acquisition (critical age around 6 years), but only in grammatical processing (including agreement), not in processing semantic information. They did control their stimuli as well as the proficiency of participants, and, interestingly enough, proficiency does not play a role in syntactic processing, whereas stronger effects of proficiency are detected in processing semantically deviant sentences. Comparing highly proficient late L2 learners with L1 speakers, they find additional bilateral activation in the inferior frontal gyrus (BA 44, 47), anterior insula, putamen, thalamus, mesial frontal cortex (BA 8), in the left frontal operculum (BA 44/6), left inferior parietal lobule (BA 40), left caudate nucleus, and in right middle frontal gyrus (BA 46/9); see (Wartenburger et al. 2003: 160). These authors conclude that AO influences syntactic processing, whereas proficiency influences semantic processing. A potentially problematic aspect of this work is that not all subjects were tested for proficiency and some of them were tested only one year after the fMRI-experiment.

Most of the studies mentioned so far contrasted monolingual L1 speakers and L2 learners. The fMRI experiment by Saur, Baumgärtner, Möhring, Büchel, Bonnesen, Rose, Musso & Meisel (2009) compared 2L1 subjects who acquired French and German simultaneously to French L2 learners of German and German L2 learners of French (12 per group), all highly proficient in both languages, age of onset 10 years or older. Special attention was paid to testing linguistic proficiency in order to be able to distinguish potential effects of proficiency from effects caused by age of onset of acquisition. Stimuli included grammatical and ungrammatical sentences in both languages, both sets exhibiting word order variation, the latter including ungrammatical order. This analysis revealed similar patterns of activation in the two L2 groups. They showed higher activation during syntactic sentence processing than in L1 in the left inferior frontal gyrus (including the pars opercularis and triangularis), the basal ganglia and the left inferior temporal gyrus. Early bilinguals, however, did not exhibit differences in activation between the two languages in these areas. This suggests that syntactic processing in the second language triggers stronger activation in the language network than the L1. Since no such effect is detected in early bilinguals, age of onset of acquisition can be argued to cause these differences.

To conclude, these neuroimaging studies all speak in favor of the claim of functional differentiation, with syntax being dissociated from semantics and pragmatics. They furthermore support strongly the hypothesis that age of onset of acquisition is a major cause for the observed differences in processing grammatical information. They also confirm that important changes happen around age 6–7, and some ERP results further show that crucial changes occur at around age 4. This kind of research cannot, however, offer more detailed insights concerning the question of which grammatical domains within the area of morphosyntax are primarily affected by the changes caused by neural maturation – at least they can not yet do so.

6. Conclusions and open questions

The starting point of my discussion was the observation that the human language making capacity is a sufficiently robust device to allow for successful language development, monolingual or multilingual, even under less than optimal conditions. This is, however, not true for successive acquisition of languages, at least not if age of onset happens after early childhood. Assuming that some properties specific to L2 acquisition indicate fundamental differences between L1 and L2, I adopted the hypothesis that crucial parts of the LAD become inaccessible as a result of neural maturation. The Critical Period Hypothesis should, however, be interpreted as a

cluster of sensitive periods, affecting only specific domains of grammar and at different periods in the course of development. Important changes seem to happen as early as approximately age 3;6 to 4, and then again at around age 6–7. These age ranges are suggested by linguistic as well as neuropsychological research, but extensive work is required before we will know which aspects of grammar are subject to maturational changes.

Let me add finally that although age of onset during the first 3–4 years of life appears to be a necessary prerequisite for the development of native competence in two languages, it may not be a sufficient one. In fact, various settings have been identified, see again Hyltenstam & Abrahamsson (2003), in which in at least some domains there exists a risk of incomplete acquisition. Severely reduced input, e.g. due to *otitis media*, may result in sensitive period effects even with onset of acquisition during the first 3 years. The same may be true in case of delayed acquisition, e.g. in children with hearing impairments and delayed onset of acquisition of sign language or of an oral language after cochlear implants. We need to learn much more about onset of acquisition during the first three or four years of life.

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CHAPTER 13

The development of person-number verbal morphology in different types of learners

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In this chapter, the acquisition of French subject-verb agreement (in form of verbal inflections) in different types of learners is discussed. Different studies, essentially case studies on corpora of spontaneous spoken vs written adult L2 French (L1 Swedish), and on simultaneous bilingual Swedish-French children, are presented and compared.

The results suggest that the 3rd person plural (3p PL) marking in written adult L2 French is acquired relatively earlier than the corresponding marking in spoken adult L2 French (Ågren 2008). It is argued that this is related to the frequency and regularity of the written 3p PL inflection (always *-nt*) in contrast to the irregular and different markings in spoken French (zero marking or different consonants). It is further argued that the same markings in the bilingual children (2L1) are not quite as early and easily acquired as in French monolinguals (L1) of corresponding age and linguistic development. This may also be related (differently from agreement in form of subject clitics) to the frequency of the 3p PL inflection in the spoken input of these children, since their French input is reduced and 3p PL is not marked in Swedish.

1. Introduction

This chapter discusses the results of some studies of Swedish-French learners acquiring the French verbal morphology of subject-verb agreement in different acquisition situations, with regard to some specific research questions. These questions concern firstly, the possible morpho-syntactic differences between first (L1) and second (L2) language acquisition, and between monolingual (L1) and bilingual (2L1) first language acquisition; and secondly, the relation between morphology and syntax, the possible influence of Swedish on the French of the learners, and the role of input frequency of specific verb forms.

The learners studied are adult Swedish learners of French as a second language (L2), studied in both spoken and written modalities, and bilingual (2L1) French-Swedish children for whom French is one of their first languages. A comparison is also made between the latter and monolingual French children (L1).

The main claim is that French agreement verb morphology develops, in both the adult L2 learners and the child 2L1 children studied here, independently of syntax and in relation to the regularity and the input frequency of specific forms.

1.1 Verbal morphology in different learner groups

This study focuses on the agreement between a subject (pronominal or nominal) and the verb form, as in (1) to (4) below – an agreement in which learners of different types make errors of the sort indicated by * in examples (1') to (4'):

(1) *je suis fatigué*
(1') **j'e(st) fatigué*

(2) *il a un frère / j'ai un frère*
(2') *il a un frère / *je a un frère*

(3) *les restaurants sont fermés*
(3') **les restaurants est fermé(s)*

(4) *… mes amis. Ils prennent le train.*
(4') *… mes amis. *Ils prend le train.*

It is well known that verb agreement in the plural is very difficult to acquire for adult learners of French as a second or foreign language (Bartning 1998), particularly 3rd person plural agreements of type (4) above. More generally, it has often been observed that inflectional morphology is difficult for adult learners to acquire and that errors remain even at advanced levels of acquisition (Lardière 1998; Prévost & White 2000, etc.). On the other hand, according to most scholars, inflectional morphology is acquired easily and at an early stage by children in their first language(s), be they monolingual or bilingual (Meisel 1994). This discussion on verb morphology is related to the question of whether or not the acquisition process is different in children from that of adults (Meisel 1997; Herschensohn 2000). Clahsen et al. (1996) noted the existence, in the case of child L1 acquisition, of a relationship between inflectional verbal morphology and syntactic phenomena such as word order, which were acquired simultaneously or shortly afterwards. It is thus postulated that children use inflectional verbal morphology to develop their syntax. For adults, on the other hand, it has been argued that they acquire their L2 grammar differently, more slowly and word by

word (Meisel 1991, 1997), and that syntax and morphology develop separately (Lardière 1998). Such differences between L2 and L1 acquisition will be discussed using the data presented in this paper.

Another question concerns whether there is a difference in morphosyntactic development between monolingual (L1) and bilingual (2L1) acquisition. Meisel (1994, 1997) postulates that children acquire the morpho-syntax of their two languages in 2L1 acquisition in the same way as do monolingual children, i.e. without cross-linguistic influence (transfer) from one language to the other, and very rapidly. This means that 2L1 children, just like monolingual L1 children, acquire entire grammatical rules involving both inflection and syntax. However, other scholars argue for certain cross-linguistic interferences between the languages of a bilingual child (Müller & Hulk 2001). Even if the two languages are essentially separated and each follows the normal development of a monolingual child, specific differences can be shown between the languages of a bilingual child and of a monolingual child.

1.2 Verbal agreement morphology in French and Swedish

Since this study concerns French subject-verb agreement in learners who all speak Swedish, we will first consider the two language systems highlighted in this study, French and Swedish, and the way in which they express verbal agreement in person and number.

French subject-verb agreement is systematically marked only in written language, whereas in spoken French this marking is almost absent in regular verbs but is partly present in irregular verbs. Table 1 below illustrates this difference,

Table 1. Subject-verb agreement in French and Swedish (+ English translations)

	Present, Fr REG	**Present, Sw REG**	**Present, Eng REG**	**Present, Fr INT**	**Present, Fr IRR**	**Present, Sw IRR**	**Present, Eng IRR**
1p s	*je parl(e)*	*jag talar*	I speak	*je fini(s)*	*j'ai*	*jag har*	I am
2p s	*tu parl(es)*	*du talar*	you speak	*tu fini(s)*	*tu a(s)*	*du har*	you are
3p s	*il parl(e)*	*han talar*	he speaks	*il fini(t)*	*il a*	*han har*	he is
1p pl	*nou(s) parlon(s) / on parl(e)*	*vi talar*	we speak	*nou(s) finisson(s) / on fini(t)*	*nous avon(s) / on a*	*vi har*	we are
2p pl	*vou(s) parle(z)*	*ni talar*	you speak	*vou(s) finisse(z)*	*vous ave(z)*	*ni har*	you are
3p pl	*il(s) parl(ent)*	*de talar*	they speak	*il(s) finiss(ent)*	*ils on(t)*	*de har*	they are
infin	*parle(r)*	*tala*	speak	*finir*	*avoir*	*ha*	have

showing inaudible morphemes in brackets. This means that a regular verb like *parler* is pronounced /*parl*/ in all frequently used persons. Table 1 also shows verb paradigms in French and Swedish (and the English translation) of different verbs: regular (REG) verbs, in French ending in *-er*; irregular verbs (IRR): *être, avoir, aller, faire*; and intermediate verbs (INT): *prendre, finir* etc., where the 3rd person plural is audible in spoken French.

In standard Swedish, the subject-verb agreement is not marked and the verb has the same form for all persons, in all kinds of verbs. The tensed forms differ from the infinitive forms, ending normally in -a, and the past participle forms, ending in -t.

Given this lack of subject-verb agreement marking in Swedish, it is conceivable that Swedish learners of French might have problems marking a distinction that does not exist in their first language, particularly since in spoken French this agreement is rarely marked by different verbal forms.

1.3 Verbal agreement morphology versus clitic pronouns

Some researchers have proposed that subject-verb agreement in spoken French is not essentially expressed by means of suffixes or different verbal forms, but by clitic subject pronouns, which thus function almost as prefixes (Auger 1995). Differently from Swedish (and many other Germanic languages), French subject pronouns are either strong (*moi, toi, lui, eux*) or clitic (*je, tu, il, ils*), whereas Swedish pronouns are only of one type which is not clitic (*jag, du, han, dom* etc.). For more details on these contrasts and the status of pronouns in adult L2 French, see Granfeldt and Schlyter (2004).

It has been observed that, with regard to the acquisition of agreement in L1 and 2L1 (Pierce 1992; Hulk 1995; Ferdinand 1996; Meisel 1994), children tend to use clitics as agreement markers, and mark the agreement between a nominal subject / strong pronoun and a clitic subject (as in (5)), rather than between subject and verb form.

(5) ***moi je*** *veu(x) manger ça*

However, independently of clitic pronouns, researchers also discuss agreement between French subjects and verbal forms. This concerns the development of French in child 2L1 (e.g. Meisel 1994), child L2 (Paradis, Le Corre & Genesee 1998) and in adult L2 acquisition (Prévost & White 2000). In bilingual children's speech (2L1 or child L2), it has been noticed that number agreement on verbs, particularly 3rd person plural, appears later than for the singular (Meisel 1994; Paradis, Le Corre & Genesee 1998). Discussing the reasons for this, the authors

point out that this form is semi-systematic and not frequently marked, but they also maintain that person agreement can be considered a more important grammatical relation than number marking.

2. Verbal agreement morphology in adult L2 learners

2.1 Spoken French L2

Subject-verb agreement in Swedish-speaking adult learners has been studied at all levels of proficiency, from complete beginners up to extremely avanced learners. In this section, we will summarize previous findings in this domain. Bartning and Schlyter (2004) and Schlyter (2003b) summarize research on different phenomena in the acquisition of French by Swedish adults in the form of developmental sequences and propose six stages of development on this basis. When establishing the developmental sequences and stages, a great number of grammatical phenomena were studied, subject-verb agreement amongst others. Since these stages are crucial for the comparisons of the relation between morphology and syntax, and for the comparison between spoken and written learner French, they will be presented here (from Ågren, Granfeldt and Schlyter, to appear):

> The description of these developmental stages takes the is shown in the form of *grammatical profiles* which can serve as an evaluation tool for the level of morphosyntactic development of a particular learner at a specific moment in the acquisition process. These grammatical profiles are briefly sketched below:
>
> – *Stage 1 (initial)*: At this stage, very little verbal morphology is used. The learners use a high degree of non-finite verbs in finite contexts (and *vice versa*), which basically means that they talk "in the infinite" (*je manger / je parler français*). They often use NPs in isolation by omitting the verb. The negation is mostly found in front of the NP (*non grand-lit*). However, grammatical morphemes are not absent altogether since one can observe definite and indefinite articles and certain pronouns (*je/il*), but the pronouns are often stressed and not amalgamated.
> – *Stage 2 (post-initial)*: At this stage, verbal morphology is starting to be used (passé composé and modal verbs + infinitives) even though tense markers and subject-verb agreement are still lacking in many obligatory contexts. Subordination emerges at this stage and negation begins to be used in combination with a finite verb. However, the negation is sometimes still placed in non-target-like positions. The object pronoun

is used in post-position (**je voir le*) and prepositions are very often non-amalgamated: **à le, *de le, *au le*.

- *Stage 3 (intermediate)*: At an intermediate stage, the use of verbal morphology is more stable than at initial stages. Especially for the auxilary verbs (*j'ai/il a*) and the modal verbs (*je vais/il va*) there is an opposition between the first and third person singular. Moreover, the agreement of lexical verbs in the first person plural is emerging (*nous parlons*). However, there are still many incorrect verb forms left in the interlanguage at this level of development, *i.e.* non-finite forms in finite positions, singular forms in plural contexts, *etc*. Negation is used in a targetlike manner whereas object pronouns are sometimes placed in the intermediate position which results in targetlike forms (*je vais le voir*) alongside with non-targetlike forms (*j'ai *le vu*).
- *Stage 4 (low-advanced)*: At this relatively advanced level, learners hardly ever produce non-finite forms in finite contexts. However, not always native-like in function, more complex tenses, like pluperfect and conditional, appear in the interlanguage. The subjunctive also emerges at this level of performance, at least in some contexts. Moreover, negation is used in different variants (*ne … jamais/rien*) and object pronouns have obtained a clitic status and are thus placed in the target-like preverbal position (*je l'ai vu*). The amalgamated articles are produced in a correct way (*du, au, des…*) by most learners.
- *Stage 5 (medium advanced)*: At this level, the complex verb forms are produced correctly (*plus-que-parfait, futur simple* and *conditionnel*) and subjunctive is more often productively used. Verbal agreement in third person plural no longer causes problems with certain frequent verbs (*ils sont/ont/vont*). Alongside the use of object pronouns in a target-like manner, one notices the emergence of the pronominal forms *en* and *y*. Moreover, the use of *gerondif* is emerging, which signals a greater concentration of information.
- *Stade 6 (high advanced)*: At this high level of proficiency, the use of inflectional morphology is stable, even in multi-propositional sentences. Only now does the use of subjunctive become native-like and SV-agreement in third person plural of lexical verbs is correctly produced (*ils prennent/boivent/veulent*). One can also notice a very high degree of embedded structures and ellipses.

If we compare these developmental stages in adult L2 acquisition with the general development of French as L1 (Heinen and Kadow 1990), it seems that syntactic phenomena, like the use of free auxiliaries and modals, negation, and not least subordinations, are used at a relatively early stage in adult L2 acquisition, compared to the development in L1.

Table 2. Order of acquisition and stages of productive use for subject-verb agreement (after Schlyter & Bartning 2005)

	Type of agreement	Examples	Developmental stage
1	singular of copula and auxilaries	*suis – es(t) / ai – a(s) / vais – va(s)*	2, post-initial
2	1p plural	*nous* V-*ons*	2–3, intermediate
3	3p plural of 4 frequent irregular verbs	*ils ont/sont/font/vont*	4–5, advanced, low-medium
4	3p plural (audible), lexical verbs	*ils peuvent, ils prennent*	5–6, advanced, high

Isolating the verbal agreement, we established the above order of acquisition as well as the developmental stage at which a specific agreement form becomes productive in adult L2, see Table 2.

We may thus observe a slow and gradual development of subjet-verb agreement in adult L2 learners. This development extends over a period of about three years and is different for each agreement form. Even in very late developmental stages the 3rd person plural can be lacking (Bartning et al. 2009). Syntax, on the other hand, develops far more rapidly, in that already from stage 2 (post-initial) onwards, L2 learners generally place negations after the finite verb and use subordinates of various sorts. In (2)L1 acquisition on the other hand, productive use of subordinations is normally a late syntactic phenomenon (Heinen and Kadow 1990: 69; Meisel 1997). That is, we observe a separation of morphology and syntax in adult L2 acquisition, which seems different from children's rapid acquisition of inflectional morphology and subsequent syntactic development.

2.2 Written French L2

Recent studies have emphasised the acquisition by Swedish-speaking learners of verbal agreement in written L2 French. Gunnarsson (2006) conducted a longitudinal study of five high-school adolescents in free written narration tasks. Like most tutored L2 learners, these pupils acquired written French simultaneously with, or even before, spoken French. The author observed a rapid acquisition of the form of the 3rd person plural and noted that, whereas the singular suffixes of irregular verbs continued to be incorrect for quite a long time, plural was marked consistently once it had begun to be marked. She attributed this to the regularity (one-to-one relation) of the form and to the possibility for learners to formulate explicit rules of the sort "if plural, always *-nt*".

Ågren (2008) analysed plural morphology in Noun and Verb phrases in written French, working on a written corpus of 106 tutored learners of French at high

Table 3. Percentages of markings for the verbal agreement of the 3rd person plural in writing (after Ågren 2008: 175)

		Stage 1	Stage 2	Stage 3	Stage 4	Ctrl	Total verbs
REG verbs	Contexts 3PL	59	121	188	121	257	746
	% correct agr.	**20%**	**54%**	**75%**	**91%**	**89%**	
	SD	15%	37%	33%	12%	18%	
IRR verbs	Contexts 3PL	53	175	223	129	107	687
	% correct agr.	**30%**	**67%**	**86%**	**98%**	**100%**	
	SD	33%	31%	19%	2%	0%	
INT verbs	Contexts 3PL	15	51	105	70	88	329
	% correct morph agr.	**13%**	**57%**	**82%**	**96%**	**98%**	
	SD	37%	46%	30%	3%	7%	
Total verbs		127	347	516	320	452	1762

school in Sweden. The students were at different levels ranging from beginners to fairly advanced learners, and the tasks were constructed so as to elicit a great number of references to the plural. Ågren classified the learners in her corpus into the general developmental stages presented above, following the criteria of Schlyter and Bartning (2005). She compared the written production of subject-verb agreement in 3rd person plural in three different groups of verbs (see Table 3): The large group of REG verbs (*ils parlent*), the very frequent IRR verbs (*ils sont/ont/vont/font*) and, finally, the INT verbs, characterized by a stem alternation in the plural (*ils prennent, ils veulent...*). As shown in Table 3, the development of plural morphology takes place rapidly in all groups of verbs, reaching 75 precent of correct agreement (*-nt*) already at stage 3. However, the learners mainly produce a morphological agreement whereas the (audible) stem alternation is not always produced as in the target language. Comparing these written data with the oral data of Bartning and Schlyter (2004) and of Schlyter and Bartning (2005), Ågren (2008: 188–191) thus argued that, compared to the other criteria serving to establish the developmental stages, the 3rd person plural agreement on different groups of verbs appears and becomes productive in written L2 French well before it does in spoken language.

How does one account for this result? The learners are comparable – young, middle-class Swedish speakers, educated in Swedish and English – thus, the difference is not related to the learners themselves. This means that neither cognitive nor functional problems are responsible for the late acquisition of these forms in spoken French. Rather, the regularity, *i.e.* the one-to-one form-function correspondence, makes the written 3rd person plural easy to acquire (Gunnarsson 2006; Ågren 2008), whereas the oral forms of this agreement are not systematic.

Such a regularity may also account for the relatively early acquisition of the 3rd person plural in spoken Italian by adult Swedish-speaking learners (Bardel 2000: 177–183). This form in spoken Italian is regular and frequent, always ending in *-ono*, and is acquired at the same time as the 1st and 3rd persons singular, i.e. relatively early.

These data taken together indicate that it is not the functional notion of "plural" that makes the French 3rd person plural forms difficult to acquire. Instead, the frequency of a specific form in proportion to other forms of the paradigm and the more or less systematic manner in which these forms are expressed plays an important role for the speed of acquisition.

3. The verbal agreement morphology of bilingual 2L1 children

Adult L2 learners of French, as shown above, produce the 3rd person plural forms of verbs in spoken French at a very late stage compared to their use of syntactic constructions. If we assume that bilingual children (2L1) do not differ from monolingual children in the acquisition of their two languages, it might be supposed that the French verbal agreement morphology will be acquired more rapidly in Swedish-French 2L1 children than in adult L2 learners. According to the literature on monolingual French L1 development, plural verbs were found to appear for the first time between the ages of 2;2 and 2;9, depending on the child (Rasetti 2003). This seems to precede late syntactic development (e.g. subordination) which according to Heinen & Kadow (1990: 69) appears between 2;6 and 3;3. To see whether this supposition was correct, agreement verb forms were studied in Swedish-French simultaneously bilingual (2L1) children.

3.1 Data

The data for the study of 2L1 development stem from a corpus of bilingual children studied by Schlyter since 1991. The children acquired French and Swedish from birth, normally with a French-Speaking mother and a Swedish-speaking father. They all resided in Sweden. The children were recorded between the ages of about two and four years at intervals of two (Jean, Anne) or four months (Mimi, Dany). For Anne, Mimi and Dany, French was slightly dominant at the start, whereas for Jean the dominant language was Swedish. From the age of about three years, the two languages were more or less balanced in all these children.

This already existing corpus, as well as the L1 control corpora of Philippe (M. Leveillé) and Grégoire (C. Champaud), were analysed in the same way, with

a search through the corpora of all occurrences of *je, tu, il, elle, on, ils/les N* as subjects, and the verbs they appeared together with. (In this way, no omissions of subjects were studied, only the agreement with a realized subject).

In the French spoken by the bilingual children, certain forms appear noticeably late. An example of unmarked 3rd person plural from Mimi at 3;2 years of age is shown in (6):

(6) Mimi: (3;2)
Mother: *qu'est-ce que tu as fait avec eux*?
Mimi: *les (enfants) il(s) a dit*
Mother: *ils ont dit*
Mimi: *il(s) a dit*
Mother: *ils ont dit*
Mimi: *# les les mains clac clac clac, les enfants*
Mother: *ils ont fait clac clac clac les enfants*
Mimi: *et les enfants il(s) a dit*
Mother: *ils ONT dit*
Mimi: *et (puis eux) il(s) fait hehehe*

In our corpus of 2L1 children, the subject-verb agreement forms were calculated on the person-marking verbs *être, avoir, aller* (and partly *faire*). A distinction was made between, on the one hand, the age at which the child distinguished between clitic subject pronouns (*il/on/elle* etc. in opposition to *je*), but not yet between the verbal forms; and, on the other hand, the age at which the child began to use the different forms of a given verb in agreement with the subject (*je suis* vs *il est, j'ai* vs *il a, il a* vs *ils ont*, etc.). A first productive use was considered when at least two forms existed (e.g., *ont* et *sont*) or when agreement was correct in most contexts (corresponding globally to the criterion of 75% in adults). In some 2L1 children, we also found lexical verbs that agreed with the plural subject (e.g. *ils dorment*), but since these verbs occurred only rarely, they were not taken into consideration here.

Table 4 below shows the ages at which the different forms of subject-verb agreement, clitic or verbal, appeared in this way in monolingual (L1) children (Grégoire and Philippe from the CHILDES corpus) and in bilingual (2L1) French-Swedish children (Mimi, Jean, Dany and Anne).

The results show that there is apparently a large gap between the age at which children first distinguish the different clitic subject pronouns (line 1–2) and the age at which they also managed to actually mark the agreement with different verb forms, including 3rd person plural (lines 3–6). This is particularly clear for the bilingual children, for whom the gap is around a year and a half. The gap for the monolingual children, on the other hand, is far smaller, 5 months at the most.

Table 4. Age of first productive use of agreement verb forms in L1 and 2L1

		Greg L1	Phil L1	Mimi 2L1	Jean 2L1	Dany 2L1	Anne 2L1
1	Scl 3SG *il* etc.	1;9	< 2;1	2;0	1;10	2;2	2;6
2	**Scl 1SG *je***	**2;0**	**< 2;1**	**2;2**	**2;6**	**2;6**	**2;6**
3	*j'ai / il a*	2;3	2;2	2;2	3;11	3;2	3;1
4	*je* suis / *il est*	2;3	2;3	3;10	3;5	3;10	4;0
5	je *vais* / il va	2;5	2;3	3;10	3;9	3;6	3;7
6	*ont/sont/font*	2;5	2;3	3;7	2;11	4 ;2	3;5

Table 5. Person agreement in the form of clitics vs verbal forms in relation to the appearance of syntactic phenomena in bilingual children

	Scl *il/elle…* + *je*	**Verb+Neg; Aux, Mod**	**Subordination**	**Agreement of all verbal forms**
Mimi	2;2	2;2	2;2–2;10	3;10
Jean	2;6	2;4–2;6	2;9	3;11
Dany	2;6	2;6–2;10	3;2	4;2
Anne	2;6	2;6–2;8	3;3	4;2

In these bilingual children, verbal agreement forms clearly appear at a later stage than most of the syntactic development. Table 5 illustrates the differences, according to previous analyses of the same children (Schlyter 2003a) on the development of negation, subordination and other phenomena.

Since verb agreement forms appear later than syntactic phenomena, these results do not seem to be in accordance with the hypothesis claiming that verb morphology triggers syntax in (2)L1 acquisition. (We do not know, however, whether the monolingual children also behave in this way or if they acquire syntax more or less simultaneously.)

Only the clitic subjects in various forms (*il/je* etc.) and without specific verbal agreement, appear quite early on: at the age of 2;6 for Anne, Jean and Dany and of 2;2 for Mimi. Simultaneously or shortly thereafter, the children produced the negation following a finite verb and began to use auxiliaries and modals. Our results thus confirm the conclusions of other researchers (Pierce 1992; Meisel 1994; Ferdinand 1996, etc.) that in (2)L1 acquisition the marking of person is essentially expressed by means of clitic subject pronouns. Thus, it is plausible that in L1 development of French the verbal agreement forms and suffixes do not have the same status as their German counterparts.

How can we account for the late development of many of these agreement forms? One conceivable reason for the delay might be the influence of Swedish,

since Swedish does not mark person/number agreement (Müller & Hulk 2001; Schmitz et al., forthc). Such a hypothesis is not possible to verify here since we would need a comparison with bilingual children acquiring French and a similar language with clearly marked agreement, for example German.

Another possibility is to try to relate the appearance of these forms to the frequency of each specific form in the input. This has been shown to be an important factor for the acquisition of morphology (Bybee 1991; Ellis 2002, and others). What is rather astonishing in Table 5 is, for example, the very late appearance of the specific verbal forms for the 1st person singular, particularly the forms *je suis* et *je vais* which appear in this corpus about a year and a half after the different clitic subjects (see Table 4). Could this be a result of the low frequency of these forms in the mothers' speech?

Therefore the frequency of the verbal forms in the input was studied in the already existing database. The children had been recorded in interaction with their mothers, and these French-speaking mothers were the main source of the children's French input. The child-directed speech of the mothers in the database was therefore supposed to properly reflect the French input of each child, and a search through the entire corpus was made (around 9000 child utterances accompanied by their mothers' speech). The verb forms considered were *suis, ai, vais, es, as, vas, est* (except *c'est*), *a, va* and the ending *-ont* (=*sont, ont, vont, font*). The proportions of verb forms in the interacting mothers' speech were very similar for all mothers, so only the overall proportions are shown in Table 6 below.

We can observe that the 2nd and 3rd person singular are by far the most frequent forms. Since 2nd and 3rd person forms in these verbs are not different in spoken French, these forms (*a(s), va(s), es(t)*) together constitute 84% of the forms in the children's input. It is therefore natural that these forms serve as default forms and are overextended to 1st person and to 3rd person plural. Also the late appearance of *je suis* etc in the children's speech can be accounted for by (low) frequency, since 1st person singular is only used in 7% of all these person-marked utterances.

In their discussion of subject omissions in bilingual children (French-Italian-German), Schmitz et al. (forthcoming) also found cases of lack of agreement, and

Table 6. Interacting mothers' use of (subject +) verbs with audible person marking (*être, avoir, aller, faire*)

1st singular *ai vais suis*	**2nd singular** *as vas es*	**3rd singular** *a va e(st)*	**3rd plural** *ont vont sont font*	**Total**
172	663	1471	249	2555
7%	26%	58%	10%	

as in our data an overuse of the 3rd person singular. They discuss this in a generative framework, representing 3rd person singular as the 'default form'. This is not incompatible with a usage-based view of the acquisition of these forms, since default forms normally correspond to the most frequent forms in the paradigm (Bybee 1985: 54), just as is also shown here.

One should further note the difference in bilingual and monolingual children's general exposure to French. Whereas French-speaking children living in a French-speaking country have the opportunity to hear these verbal forms in the rich and varied input produced by people of all ages with whom they come into contact, bilingual children living in Sweden are generally exposed to the French of only one French-speaking person. This reduced input – even if perfectly target-like and not a 'contact variety' (cf. Hauser et al., forthcoming) – makes it difficult for the child to acquire these irregular forms and may thereby explain the delay of their production.

4. Conclusion and discussion

In this paper, some studies on the acquisition of verb forms were presented and the different results were discussed. The different studies referred to had separate research questions and goals, but the general overview of them was used here to discuss questions concerning the acquisition of verb morphology. The results can be summarized as follows:

Spoken adult L2: The adult L2 learners acquired verbal agreement forms very late. Even at a developmental stage where they have a good mastery of French syntax, including auxiliaries, subordination etc., they are still far from having developed the verbal agreement morphology, especially of the 3rd person plural agreement. Many studies on L1 acquisition, on the other hand, mention that verb morphology is acquired rapidly in L1 and in conjunction with syntax, so there is apparently a strong contrast between adult second language (aL2) and first language (L1) acquisition.

Written vs spoken adult L2: The development of the 3rd person plural suffix is different in written and spoken L2 French. In spoken French, this agreement is mastered very late, but not in the written modality. The studies presented here show that, in writing, the development is far more rapid than in the oral modality. (But still, the learners master the forms in a gradual and regular way). The more rapid acquisition in written French is argued to be a result of the one-to-one form-function relationship of the written 3rd person plural forms (Gunnarsson 2006; Ågren 2008), since 3rd person plural is constantly marked by *-nt* in the input, differently from spoken French. Consequently, the delay with the 3rd person

plural in spoken L2 French cannot stem from functional or semantic causes, nor could it be entirely due to the influence of Swedish.

2L1 vs adult L2 (verb forms vs clitics): Results for adult learners were compared to those of simultaneous bilingual (2L1) children aged around 2–4 years (therefore spoken French). The aim was to verify the hypothesis that verbal morphology in children is acquired by very rapid acquisition which also includes the simultaneous or subsequent acquisition of syntax (Clahsen et al. 1996). In our data, however, only the clitic subject pronouns, not the verb forms, were acquired by the children in this way, which supports previous findings on French (Hulk 1995; Ferdinand 1996). Contrasting with this, we could observe that verbal agreement forms, at least in the bilingual French-Swedish children, were acquired with a considerable delay – about 20 months – compared to the acquisition of clitic subjects. The verb forms also appeared later than the syntax of the simple sentence (negation, subordination, etc.). This suggests that the verbal agreement forms in French (if we suppose that 2L1 develops like monolingual L1) do not have the same role for the development of syntax that they do in for example German child language (Clahsen et al. 1996; Meisel 1997).

Bilingual (2L1) vs monolingual (L1) development: The data presented here show differences between French agreement verb forms in monolingual French children and in Swedish-French bilinguals (2L1). The later appearance of these forms in 2L1 could possibly be due to cross-linguistic interference from Swedish, where agreement is not marked on verbs, but this is impossible to study without contrasting data from another language combination.

Another hypothesis studied was the relation between the early and late appearance of the forms in the children's speech and their frequency in the input (Bybee 1985; Ellis 2002). Such a relation was clearly observed in our data, in that the 3rd/2nd singular forms (*es(t), a(s), va(s)*) were the overwhelmingly most frequent ones in the mothers' speech, which can account for their early acquisition and their overuse. The late appearance of 1st person singular and 3rd person plural verb forms in the children's speech can also be accounted for by their very low frequency in the input.

It is possible that the gradual appearance of agreement verb forms in adult L2 acquisition can also be accounted for by the regularity and the relative frequency of the specific forms in the input (Schlyter & Bartning 2005). The relation between input frequency of "finite" versus "non-finite" verb forms (type /*parl*/ vs /*parlE*/) and their use in adult L2 learners' production has been shown empirically (Thomas 2009), but the agreement forms in adult L2 learners still need to be studied in detail.

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CHAPTER 14

Re-thinking the bilingual interactive-activation model from a developmental perspective (BIA-d)

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A large body of empirical research, accumulated over the last twenty years, has set the foundations for a generic model of word comprehension in relatively fluent bilinguals (the bilingual interactive-activation (BIA) model). This approach combines an initial language non-selective access process with inhibitory control mechanisms in order to limit cross-language interference. However, it is still not clear how such an architecture could emerge during the learning of a second language. The present chapter briefly summarizes the key results in favor of the original BIA-model and describes the research agenda that hopefully will help fill in the "missing link" – that is, a developmental investigation of second language vocabulary acquisition. We present a theoretical framework (the developmental BIA-model, BIA-d) designed to guide future research in this area.

1. Introduction

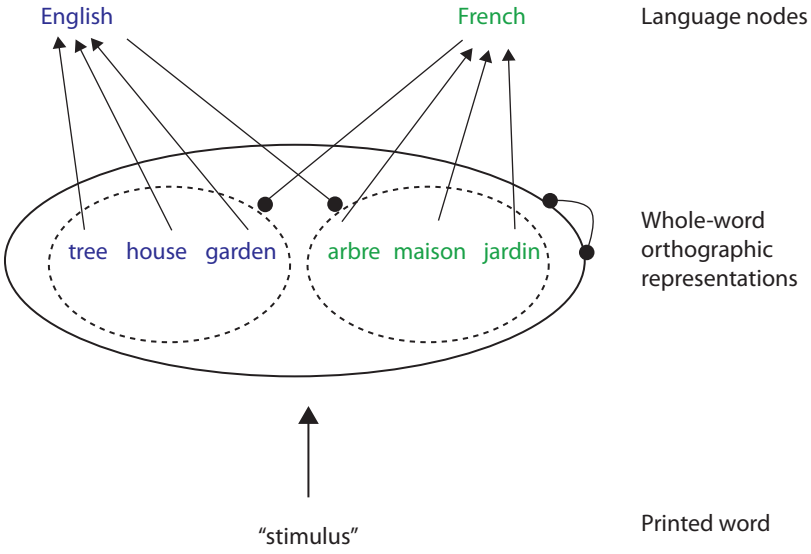
A long-standing debate in the literature on bilingual language comprehension concerns the relative permeability of the representations dedicated to processing each language in relatively fluent bilinguals. Traditionally, this debate has opposed proponents of early language-selective processing with proponents of a non-selective access to a set of representations shared by both languages. The language-selective hypothesis is typically associated with the notion of a switching mechanism that guides the linguistic input to the appropriate set of language-specific lexical representations (Macnamara 1967). According to this hypothesis, there should be no cross-language interference when the language of the incoming information is completely predictable (i.e., in a monolingual context). When

this is the case, information extracted from the stimulus is sent directly to the appropriate set of language-specific representations. The non-selective access hypothesis proposes, on the other hand, that the initial feed-forward sweep of information from the linguistic input can make contact with lexical representations from both languages as a function of their orthographic or phonological overlap with the input. This was the founding hypothesis of the Bilingual Interactive-Activation model (BIA-model) first described by Grainger & Dijkstra (1992), and implemented by van Heuven, Dijkstra & Grainger (1998).

2. The Bilingual Interactive-Activation (BIA) model

In the Bilingual Interactive-Activation model, selection by language operates top-down, by selectively enhancing the processing of representations in one language (and/or inhibiting those in the other language). Language nodes perform this function by integrating information extracted from the stimulus with contextual information conveying the likelihood that the current stimulus is from one or the other language. The relative activation of these language nodes indicates the probability that the stimulus is a word in a given language. Thus, the BIA-model implements late selection via top-down control from language nodes to word-level representations. In other words, given sufficient processing, only representations associated with the appropriate language will remain activated. The architecture of the model is shown in Figure 1. Note that until now the model has only been applied to the simplified case of processing printed words in languages that use the same alphabet. Nevertheless, we expect the basic processing principles of the model, to be described below, to be extendable to the case of spoken word comprehension and production, and to the situation where the bilingual's two languages are written with different alphabets or scripts.

This particular account of fluent bilingual lexical processing has two important consequences. First, it is impossible to completely "switch off" the irrelevant language. Due to the principle of language-independent feedforward activation, both languages are always active to some degree. Second, co-activated representations from the irrelevant language will affect target language processing. Due to the principle of language-independent within-level inhibition, co-activated representations from the non-target language participate in the interference generated by representations of non-target words. Top-down inhibitory control from language nodes allows the BIA-model to limit the damage done by such cross-language interference. In the following sections, we discuss the evidence for, and the consequences of, these basic processing principles of the BIA-model.



For languages sharing the same alphabet (e.g., English and French), a printed word stimulus can activate whole-word orthographic representations from both languages as a function of their orthographic overlap with the stimulus. All activated representations enter in the competition for word identification, but the probability that a given word is in fact the stimulus is regulated by the probability that the stimulus is a word in one or the other language (as indexed by the activation of language nodes).

Figure 1. The Bilingual Interactive-Activation (BIA) model

3. Evidence for cross-language interference

According to the principle of non-selective access implemented in the BIA-model, cross-language interference should be observable in even the most monolingual of processing situations (e.g., reading a book written in one language), although the size of such interference effects can be quite small and therefore difficult to observe (e.g., Lemhöfer, Dijkstra, Schriefers, Baayen, Grainger & Zwitserlood 2008). However, most of the early evidence concerning cross-language interactions was in fact in favor of the language-selective access hypothesis. This evidence was provided by language switching experiments (Macnamara & Kushnir 1972; Soares & Grosjean 1984; Grainger & Beauvillain 1987; Thomas & Allport 2000; Alvarez, Holcomb & Grainger 2003), showing that switching languages incurs a processing cost compared to a situation where there is no language switch. Thus, for example, in Grainger & Beauvillain's (1987) study, lexical decision responses to words in one language were slower when the word on the preceding trial was from the other language compared with a word from the same language. Although switch costs have traditionally been taken as evidence for language-selective access,

Grainger & Dijkstra (1992) provided an interpretation within the framework of the BIA-model. In mixed-language lists, language node activation is determined by the language of the word on the previous trial. When this is a word from the other language, language node activation is therefore initially incompatible with the current target, and hinders processing. Therefore, language switch costs are not necessarily diagnostic of language-selective access. We return to examine the issue of language switch costs in more detail in the following section.

More direct evidence for non-selective access was provided by experiments demonstrating cross-language interference using bilingual versions of the Stroop task (Dyer 1973), the flanker task (Guttentag, Haith, Goodman & Hauch 1984), and experiments showing evidence for co-activation of non-target language representations during the processing of cross-language homographs (e.g., Beauvillain & Grainger 1987; de Groot, Delmaar & Lupker 2000; Dijkstra, Grainger & van Heuven 1999; Dijkstra, Timmermans & Schriefers 2000) and cross-language homophones (e.g., Brysbaert, Van Dyck & Van de Poel 1999; Duyck 2005; Nas 1983; Dijkstra et al. 1999). These cross-language influences have generally been interpreted as showing that bilinguals cannot block interference from the irrelevant language. However, proponents of selective access have argued that the mere presence of words in the irrelevant language (as is the case in Stroop and Flanker interference experiments) is enough to prevent processing in a pure "monolingual" mode (Grosjean 1988). The same argument can be leveled against research examining processing of cross-language homographs and homophones, since these stimuli are also words in the other language. In order to provide more convincing evidence in favor of non-selective access, cross-language interference must be demonstrated in conditions where there is no explicit activation of the irrelevant language.

These conditions were respected in the experiments reported by van Heuven et al. (1998). Contrary to all prior research, these authors did not explicitly manipulate the presence or absence of other language stimuli. Rather, they manipulated potential cross-language interference in the form of words from the other language that are orthographically similar to target words (so-called orthographic neighbors – Coltheart, Davelaar, Jonasson & Besner 1977). Prior work has shown that within-language manipulations of this variable significantly affects performance in standard word recognition tasks (e.g., Andrews 1989; Carreiras, Perea & Grainger 1997; Grainger 1990; Grainger, O'Regan, Jacobs & Segui 1989). Van Heuven et al. (1998) found a significant effect of number of orthographic neighbors both within languages and across languages in bilingual participants (see also Grainger & Dijkstra 1992). Most important, the cross-language neighborhood effects disappeared in an experiment testing monolingual participants with the same materials. Therefore, as predicted by the BIA-model, the cross-language

neighborhood effect found in bilingual participants suggests that the processing of a given word (among a list of words from one language only) generates activation in orthographically similar words not only within that language but also in the other language. A similar pattern of effects was observed in the electrophysiological data in Midgley, Holcomb, van Heuven & Grainger's (2008) study. In this study, words with several cross-language neighbors generated a more negative-going ERP waveform in the N400 window than words with no cross-language neighbors. Finally, an ERP study by Thierry & Wu (2007) revealed implicit activation of L1 lexical representations during processing of the L2. Participants in their study had to judge the semantic similarity of two English (L2) words, and unknown to participants, in one condition the Chinese translations of the two words shared a character. Implicit character repetition significantly affected N400 amplitude during the processing of English words.

Therefore, the evidence from behavioral and ERP research converges on a model of bilingual language processing that is initially language non-selective. In the BIA model, this initial phase of language non-selective access is followed by rapid convergence on the appropriate language-specific representation due to the conjoint operation of top-down and lateral inhibitory mechanisms. In such an approach, words from both languages compete for recognition in an integrated lexical network. The influence of cross-language lateral inhibition is reflected in the interfering effects of neighbors from the non-target language found in the studies of van Heuven et al. (1998) and Midgley et al. (2008) described above. The influence of top-down inhibitory control is reflected in the effects of language switching, to be described in the following section.

4. Language switching and the BIA-model

Perhaps the most original aspect of the BIA-model is the use of language nodes to control for the potential interference generated by non-target language representations. The language node mechanism of the BIA-model combines top-down inhibitory control of lexical activation with a mechanism for coding for which language a word belongs to (a kind of language tag). As noted above, this allows the BIA-model to capture language switching effects that have been demonstrated in a number of behavioral studies of language comprehension (e.g., Grainger & Beauvillain 1987) and language production (e.g., Costa & Stantesteban 2004; Meuter & Allport 1999) in bilinguals. In comprehension, switch costs arise from bottom-up activation of a given language node driven by presentation of a word in that language, leading to inhibition of lexical representations in the other language. In production, the appropriate language node is activated top-down in

order to ensure that only lexical representations in the target language are selected for output. Again this generates inhibition in lexical representations in the other language. This account of language switching effects explains why switch costs tend to be greater from L2 to L1 in language production (e.g., Costa & Stantesteban 2004; Meuter & Allport 1999), and from L1 to L2 in language comprehension (e.g., Grainger & Beauvillain 1987; Von Studnitz & Green 2002). Both asymmetries arise from the postulate in the BIA-model that L1 lexical representations have higher resting level activations than L2 words, since they have been encountered more often. Due to this, L1 words require more top-down inhibition during the production of an L2 word than vice versa, and therefore are subject to greater interference than L2 words following a language switch. In comprehension, on the other hand, L1 words generate more bottom-up input to the L1 language node than L2 words for the L2 language node, and therefore generate more interference than L2 words when there is a language switch.

However, a popular alternative account of switch costs is that they are almost exclusively the result of executive control factors and related to how participants control their decisions and responses in a laboratory task (Dijkstra & van Heuven 2002; Green 1998; Thomas & Allport 2000). In Green's (1998) inhibitory control (IC) model, the concept of task schemas plays a central role in accounting for switch costs in the comprehension and production of language in bilinguals. Task schemas are part of a general task control system, and are used in the bilingual situation to link the output of lexical processing to a specific behavioral response. They are mutually inhibitory such that after using task schema A, it is harder to apply task schema B than to repeat task schema A. Since producing language always requires a behavioral response, the IC model has found interesting applications in this area (see e.g., Finkbeiner, Gollan & Caramazza 2006). Concerning language comprehension, on the other hand, bilinguals do not need to be informed in advance of the language of the incoming stimulus in order to understand it, hence switch costs in comprehension do not necessarily reflect the influence of task schemas. Cross-language homographs (e.g., "coin", which means "corner" in French) are the only case where knowing which language the word belongs to provides critical information for accessing the word's meaning.

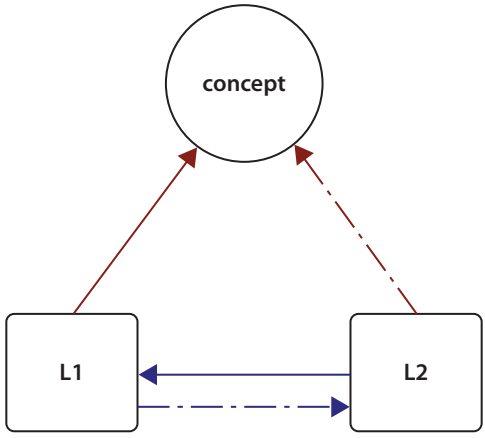
Much of the focus of laboratory research on language-switching in recent years has used situations involving a different response associated with each language (e.g., respond "yes" if the word is in a specific language and "no" otherwise), hence artificially exaggerating the possible influence of task schemas. One early study of language-switching initiated a different approach. Grainger & Beauvillain (1987) found switch costs in a generalized lexical decision task (participants responded "word" if the target was a word regardless of language, and "nonword" otherwise). In this task, therefore, the language affiliation of the

stimulus has no consequences for the required response. Such language information could therefore, in principle, be ignored, but Grainger and Beauvillain demonstrated that this information is not ignored. Lexical decision times to words in one language were slower when the preceding trial was in a different language, compared with a preceding stimulus from the same language, and these switch costs tended to be larger for L2 targets than L1 targets. This basic result was later replicated by von Studnitz and Green (1997) and Thomas & Allport (2000), and provides support for the hypothesis that at least part of language-switching effects in comprehension are being driven by a process that is independent of more general decision-related or task-related mechanisms.

Finally, the difference between the language node mechanism of the BIA-model and the task schema account of the IC model can be best captured using the distinction between endogenous and exogenous control mechanisms. The IC model only implements endogenous (top-down) control, whereas the BIA-model implements both endogenous and exogenous control via the same mechanism (language nodes). Endogenous control in the BIA-model operates via the top-down activation or maintenance of language node activation driven by the expectancy that the stimulus will be a word in a given language, or by the goal to produce a word in a given language. Exogenous control arises via the automatic bottom-up activation of language nodes via lexical representations, and the subsequent inhibition of lexical representations by language nodes. This allows the BIA-model to account for the kind of fast-acting language switching effects that have recently been observed in ERP language switching studies (Chauncey, Grainger & Holcomb 2008). Furthermore, as noted above, this distinction between endogenous and exogenous control within the framework of the BIA-model, provides an explanation for the different patterns of switching effects that have been observed in language production (effects generated principally by endogenous control) and language comprehension (effects generated principally by exogenous control). In the following sections we will address the issue of how the control mechanisms postulated in the BIA-model might emerge during second language acquisition.

5. Second language vocabulary acquisition

The model of second language vocabulary acquisition that currently dominates theorizing in this field is the revised hierarchical model (RHM) of Kroll & Stewart (1994). This is a model of second language learning in late learners, and the data cited in support of the model have generally been collected from college students in relatively early phases of second language acquisition. The model proposes that



Showing how form representations of L1 and L2 words are interconnected with concept representations. Full lines represent stronger connections than dotted lines.

Figure 2. The Revised Hierarchical Model (RHM)

as a speaker gains fluency in L2, there is a gradual shift from an indirect access to meaning via L1 translation equivalents to direct connections from L2 words to concepts (see Figure 2). Kroll and Stewart had second language learners translate words that were presented in lists blocked by semantic category (e.g. arm, head, legs) and mixed category lists (e.g. shirt, sink, apple). In support of the RHM, they found that backward translation (L2 to L1) was faster and more accurate than forward translation (L1 to L2), and only forward translation was influenced by semantic blocking.

Thus, according to the RHM, the observed asymmetries in translation times as a function of translation direction, and the sensitivity of the translation tasks to semantic blocking can be explained by the asymmetric connection strengths in the model. There are stronger connections from L2 lexical representations to the corresponding translation equivalent in L1 compared with the connections between L2 lexical representations and semantics, while L1 representations have stronger connections with semantics than with the corresponding L2 translation equivalent.

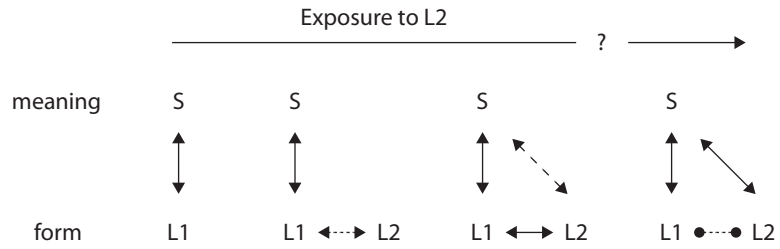
One outstanding problem for the hypothesized excitatory connections between lexical representations of translation equivalents in the RHM, is the fact that non-cognate translation priming in proficient bilinguals is a surprisingly elusive phenomenon when prime stimuli are in L2 and targets in L1 (e.g., Finkbeiner, Forster, Nicol & Nakamura 2004; Gollan, Forster & Frost 1997; see Duñabeitia, Perea & Carreiras 2010, for review). Although significant effects of

non-cognate translation primes are generally found with primes in L1 and targets in L2 (e.g., Gollan et al. 1997; Voga & Grainger 2007), the fact that the effects are weaker (and generally non-significant) from L2 to L1, is evidence against the idea that L2 lexical representations have strong excitatory connections with their L1 translation equivalents (see Midgley, Holcomb & Grainger 2009, for an ERP investigation of asymmetrical translation priming effects). More recent research has provided evidence for masked non-cognate translation priming effects from L2 to L1 in highly proficient bilinguals (e.g., Basnight-Brown & Altarriba 2007; Duñabeitia et al. 2010). This could be due to the greater proficiency in L2 enabling faster access to semantic representations from a briefly presented L2 prime word. In other words, non-cognate translation priming effects would reflect access to shared semantic representations, rather than direct connectivity between the word form representations of translation equivalents (Grainger & Frenck-Mestre 1998; Midgley et al. 2009).

The question guiding the theoretical work to be described below is therefore: Given the evidence for excitatory connections between translation equivalents in the early phases of second language vocabulary acquisition, and the evidence that such direct connectivity is no longer present in bilinguals with moderate levels of proficiency in their L2, how could a system evolve from the former state to the latter? Here we provide a tentative answer to that question.

6. Developmental Bilingual Interactive-Activation (BIA-d)

Figure 3 describes an initial proposal for describing the evolution of proficiency in late learners of a second language. More specifically, this figure describes the sequence of changes in L1-L2 connectivity that would allow an initial "RHM" model to develop into a "BIA" model. The starting point is an adult speaker of L1 who is exposed to a second language, so this account only applies for late learners of L2. Initial exposure to L2 generates connections between translation equivalents that are strengthened as exposure increases, by Hebbian learning, for example. At the same time as these connections between translation equivalents are being strengthened, direct connections begin to be established between L2 lexical representations and the appropriate pre-existing semantic representations. So far the developmental pattern is as described in the RHM (Kroll & Stewart 1994). As the direct links between L2 lexical representations and semantics are further strengthened, the connections between translation equivalents are modified as L2 lexical representations are integrated into a single lateral inhibitory network for words from both languages, as in the BIA model. This is the critical moment in the evolution of L2 proficiency indicated by a question mark in Figure 3. It



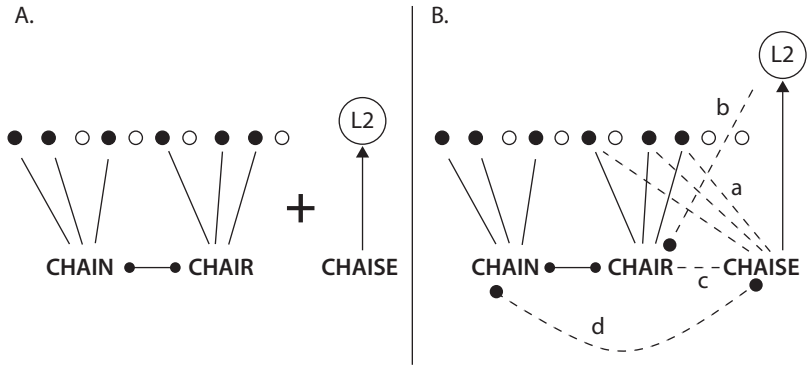
L1 and L2 refer to whole-word form representations in the first and second language, and S refers to semantic representations shared by these word forms. Arrows represent excitatory connections, filled circles represent inhibitory connections, and full lines represent stronger connections than dotted lines.

Figure 3. A tentative framework for uniting the RHM and BIA models of bilingual lexical processing

might well correspond to what many bilinguals experience as a "magic moment" in L2 acquisition when suddenly understanding and producing L2 becomes significantly less effortful.

This qualitative shift in the connectivity between the form representations of translation equivalents in L1 and L2 is likely linked to an improved control over L2 language activation that becomes necessary as L2 vocabulary grows. In the BIA-d model, to be described below, this improved control corresponds to the development of the ability to globally inhibit L1 lexical representations while processing L2 stimuli, and vice versa. This is the function performed by the language nodes in the BIA model. Clearly such a control mechanism is incompatible with excitatory connections between translation equivalents in L1 and L2. In the following sections we examine the kind of basic learning mechanisms that could account for such developmental changes involved in 2nd language vocabulary acquisition. In doing so, we move away from the static modeling approach of the RHM and the BIA to dynamic models that incorporate basic learning principles that have been applied in various areas of cognitive development, including spoken and written vocabulary acquisition (e.g., Dandurand, Grainger & Dufau 2010; Dufau et al. 2010; Li et al. 2004, 2007).

The BIA-d model, described in Figure 4, is based on general considerations of vocabulary acquisition plus constraints associated with learning words in a second language once the L1 is well established (i.e., late learners with initial exposure to L2 in the classroom). The model is simplified by representing only visual/orthographic word forms and meaning. However, we expect the same general principles to be applicable in the case of learning spoken language. The model is described for the specific case of learning a language that shares its alphabet with L1. The initial state is a set of L1 word forms connected to distributed semantic



Connections ending in filled circles are inhibitory, all others are excitatory. Dashed lines indicate connections that involve the greatest change during L2 learning. *Panel A*. The initial phase of L2 word learning for L1 English learning French. L1 word forms (chain, chair) have mutually inhibitory connections and excitatory connections with semantic representations. An L2 word (chaise) is presented and the learner is informed that this is a word in French. *Panel B*. Developmental changes in connectivity between word form representations and semantics as a function of exposure to L2 (see main text for details).

Figure 4. The developmental bilingual interactive-activation (BIA-d) model of 2nd language vocabulary acquisition

representations (see Figure 4), the use of which is a common feature of neural network models of word comprehension and production (e.g., McRae, de Sa & Seidenberg 1997; and see Kroll & de Groot 1997, for an earlier proposal along these lines). Each word form is linked via mutually excitatory connections to certain semantic features, and word forms that are co-activated by the same stimulus (orthographically similar words) and that are semantically incompatible (share no semantic features) have mutually inhibitory connections (following principles of winner-take-all networks – McClelland & Rumelhart 1981).

According to the BIA-d model, there are two largely overlapping phases of L2 vocabulary acquisition in late learners learning their L2 essentially in a classroom environment: an initial phase of supervised learning which is progressively replaced by unsupervised learning. In classroom learners of an L2, initial word learning is supervised in that the learner is told that the new word form is a word in L2 and that it corresponds to the translation of a given word in L1 (directly or indirectly). This leads to co-activation of the L2 word form representation, plus the equivalent L1 word form and the corresponding semantic representation, as well as information indicating that the new word form is a word in L2 (i.e., an L2 language node or language tag). In practice, network training during this initial phase of L2 acquisition involves clamping the activation of the word form representation of the L1 translation equivalent to some maximum value (for

supervision), and creating a language node with initially low activation level. The L1 translate activates its corresponding semantic features. Connections between the L2 word form and the L1 translate, the corresponding semantic features, and the L2 language node, are strengthened via Hebbian update. Thus, the initial phase of L2 vocabulary acquisition involves presentation of a new L2 word form accompanied by two other pieces of information: the meaning of the word (provided by clamping activation of the translation equivalent in L1), and information indicating that this is a word in L2. Hebbian learning leads to the strengthening of connections across compatible co-activated representations.

When a given L2 word form representation reaches a critical activation level without clamping the L1 translate, then the clamping process is dropped. This corresponds to the second (unsupervised) phase of L2 vocabulary learning. Connections between the L2 word form and semantic features and the L2 feature continue to be reinforced via Hebbian learning. The shift toward L2 autonomy (at the level of vocabulary) is reinforced by the development of top-down inhibition from the L2 language node to the L1 translation equivalent. This inhibitory connection is reinforced as the L2 language node activation increases, and is accompanied by a corresponding decrease in the strength of the excitatory connection between the L2 and L1 word form representations. Recent evidence for the role of L1 inhibition during L2 acquisition has been provided by Levy, McVeigh, Marful & Anderson (2007) and Linck, Kroll & Sunderman (2009). Linck et al. suggest that immersion in an L2 environment might be critical for developing such L1 inhibition, a possibility that clearly requires more work contrasting L2 acquisition in classroom and natural contexts.

Thus, the following developmental changes are hypothesized to occur as a function of exposure to L2 word forms (see Figure 4, panel B): (a) excitatory connection strengths from L2 word forms to semantics gradually increase; (b) the inhibitory connections from the L2 language node to L1 word forms gradually increase; (c) the excitatory connections between L2 word forms and the word forms of their L1 translates gradually increase, and then decrease as the inhibitory input from the L2 language node increases and the L1 clamping process is dropped; (d) inhibitory connections develop from the L2 word form to other orthographically similar words in L2 and L1.

This gradual integration of L2 word forms into an integrated lexicon (i.e., with between and across language connectivity) is accompanied by increased cross-language interference. Our approach provides a tentative account of how control over the relative activation levels of lexical representations in L1 and L2 is developed in order to limit such cross-language interference. The hypothesized foothold into this control system is the L2 language node (or language tag) that accompanies early L2 vocabulary acquisition. As L2 vocabulary size increases,

accompanied by an increase in L2 autonomy, it is the higher co-occurrence of words within languages than across languages that takes over as the main regulator of cross-language interference (e.g., Hernandez, Li & McWhinney 2005). However, in our approach this co-occurrence is represented via connectivity between word forms and language nodes (one for each language) rather than in the connectivity patterns at the level of word forms, as proposed by Hernandez et al. The final form of the network (i.e., as a proficient bilingual) is therefore functionally equivalent to the BIA model supplemented with a layer of semantic representations.

One key aspect to this approach is that the joint action of increased excitatory weights from the L2 word form to semantics and increased inhibitory weights from the L2 node to the L1 word form, causes the excitatory connection between L1 and L2 word forms to gradually decrease. On the other hand, the inhibitory connections between the L2 word form and formally similar and semantically incompatible L1 words (e.g., chaise – chain) will gradually increase in strength. Therefore, according to this approach, L2 words are rapidly integrated into a common word form lexicon, developing inhibitory connections with both L2 and L1 words that are both formally similar and semantically incompatible. Key evidence in favor of non-selective access to an integrated lexicon was provided in the preceding sections on the BIA model. Furthermore, the evidence at present suggests that the initial excitatory connectivity between L2 word forms and their translation equivalents in L1 (as postulated in the RHM and the present model) rapidly disappears as proficiency in L2 increases (e.g., Midgley et al. 2009). Finally, recent research on fast language switch effects in a priming paradigm is in favor of the type of top-down control over lexical activation in each language as implemented in the BIA model and the present extension of this approach (Chauncey et al. 2008).

7. Current research perspectives

Figure 4 provides a testable working model of L2 vocabulary acquisition in late learners, and describes a precise course of development from initial phases of L2 acquisition through to proficiency in L2. The framework predicts that several critical phenomena reported in the literature on bilingual word recognition should be strongly affected by L2 proficiency. Two prominent examples are translation priming and language switch costs. Future research should provide more fine-grained developmental analyses of these two key phenomena.

Another key question for future research concerns the extent to which early learners of an L2 (i.e., quasi simultaneous acquisition of L1 and L2) develop the

same kind of L1-L2 connectivity as highly proficient late learners. Hernandez et al. (2005) provide a clear summary of the principle reasons for why this is unlikely to be the case. These authors suggest that early L2 learners do not adopt the same kind of "parasitic" approach to L2 acquisition as late learners (as implemented in our BIA-d model and the RHM). Rather, contextual cues (e.g., mother speaks L1, father speaks L2) might provide the necessary input for self-organizing mechanisms to generate separate lexical networks for each language. Future theoretical work should provide direct comparisons of different networks, such as the BIA-d model, that implement different mechanisms for L2 vocabulary acquisition.

For example, in the modeling work of Li & Farkas (2002) on the acquisition of L2 spoken vocabulary, segregation of L1 and L2 lexical representations emerges as a result of the higher level of phonological similarity that exists between phonological word forms within a language than between languages, and the higher degree of co-occurrence of word forms within than between languages (see French & Jacquet 2004, for a similar result obtained using a simple recurrent network). Future modeling work could test the role of providing explicit information concerning the language of the input during training. This could be done by activating a language feature as one of the semantic features in the network. Performance of such a network could be contrasted with a network trained without providing explicit information concerning the language of the input. Performance in these networks could then be compared with the BIA-d model of late classroom L2 acquisition, that provides explicit information about the language of the input, plus a clamping mechanism for supervised L2 vocabulary learning described above (it should be noted that the BIA-d model could be easily extended to include self-organized learning of word form representations). Finally, age-of-acquisition of L2 could be simulated in these different networks by manipulating the amount of prior training on L1 before providing L2 input. In this respect, it should be noted that self-organizing maps are known to exhibit the properties of plasticity and stability that reveal effects of order of acquisition (Hernandez & Li 2007).

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CHAPTER 15

Foreign language vocabulary learning

Word-type effects during the labeling stage

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This chapter reviews the results of a set of experiments that examined foreign-language (FL) vocabulary learning by late learners, exploiting the paired-associate-learning (PAL) paradigm. The effects on acquisition and retention of the concreteness and frequency of the native-language (L1) words, the (phonotactical) typicality of the FL words, and the cognate relation between the L1 words and their FL translations were studied. To determine long-term retention a retest took place one week after learning. The results showed substantial effects of concreteness, typicality and cognate status: More concrete, typical, and cognate words were learned than abstract, atypical, and non-cognate words, respectively. Learning was also better for frequent than for infrequent words, but this effect was relatively small. Furthermore, the retest indicated that the words acquired best during the learning phase were also those retained best: The forgetting functions were steeper for abstract, atypical, and non-cognate words than for concrete, typical, and cognate words. We explain these effects in terms of differential pre-experimental long-term memory knowledge (concreteness and frequency), phonological short- and long-term memory (typicality), and a retrieval cue that exists for cognates but not for non-cognates (cognate status).

1. Introduction

Until the last decade of the 20th century, vocabulary received relatively little attention both in research on foreign-language (FL) learning and in the FL classroom. Due to the growing awareness that vocabulary plays a pivotal role in effective FL use, this situation has changed over the past 20 years and vocabulary learning has since become a widely studied research topic. One of the common research methods of FL vocabulary learning is paired-associate learning (PAL). This paper reports the results of a set of PAL experiments performed in our laboratory, always with late, adult learners as participants. PAL experiments on FL vocabulary

learning only deal with the very initial stage of learning, in which new names (the FL words to learn) are assigned to extant concepts, namely, the concepts associated with the FL words' translations in the learners' native language (L1). We will call this stage the "labeling" stage. Because the two terms in a pair of word translations seldom share all aspects of meaning, this parasitic use of the L1 word meanings in FL vocabulary learning inevitably leads to a strong semantic "accent" in the targeted foreign language. Through subsequent naturalistic exposure to this language (e.g., by extensive reading), the inherited L2 meanings will gradually evolve towards the targeted ones.

Below we first briefly explain the PAL method and the materials, participants and testing used in the various studies from our laboratory. Next, we present an overview of the data thus obtained, focusing on the effects of the various stimulus characteristics that were manipulated in these studies on learning. Finally, we will discuss the results in terms of pre-experimental long-term memory knowledge and phonological-short term memory.

During the training phase of a PAL experiment on FL learning, pairs of stimuli are presented to the learner. In the "picture-word association" version of the method, one of the terms in each stimulus pair is an FL word to be learned and the second is a picture depicting its meaning. In the "word-word association" version the paired terms presented during training are two words: an L1 word and its FL translation. The amount of learning that has taken place during training is subsequently tested, usually with a "cued recall" task, of which two versions occur: In "receptive" cued recall the FL words are presented as stimuli (the "recall cues") and the participants have to produce their translations in L1; in "productive" cued recall the L1 terms of the translation pairs serve as recall cues and the corresponding FL words have to be given.

In all, we ran 12 PAL experiments in our laboratory, seven of which have been published (de Groot 2006; de Groot & Keijzer 2000, four experiments; Lotto & de Groot 1998; Van Hell & Candia Mahn 1997) and five still awaiting to be reported on. All experiments focused on the effects of one or more manipulations of the stimulus materials on both the acquisition and retention of the FL vocabulary to learn. These manipulations concerned the L1 words in the translation pairs presented for learning, the FL terms in these pairs, and the relation between the lexical forms of an L1 word and its FL translation. Specifically, the stimulus variables manipulated across the studies were cognate status (whether or not the two terms in a translation pair share phonology and/or orthography), concreteness (whether an L1 word – but thus also its FL translation – refers to a concrete entity or to an abstract concept), word frequency (whether the L1 word in a translation pair is commonly used or occurs infrequently instead), and phonotactical typicality (a

measure of the degree in which the phonological structure of an FL word to be learned resembles the sound structure of the learner's L1 words).

The participants in our studies were always university undergraduates with Dutch as their native language and considerable prior experience in learning foreign languages. In all studies word-word PAL was used. Lotto and de Groot (1998) compared word-word PAL with picture-word PAL, and Van Hell and Candia Mahn (1997) compared word-word PAL with the keyword method (see there for details). The other studies all used word-word PAL only. In two of the published studies (de Groot 2006; de Groot & Keijzer 2000) and in all of the unpublished ones, the FL words to be learned were not words from a natural language but nonword letter strings that we made up ourselves. Using such artificial words as the foreign vocabulary to be learned enables the systematic manipulation of some of the variables under study (cognate status and phonotactical typicality). Finally, de Groot (2006) and all unpublished studies also looked at the effect of various types of background music (vocal and instrumental; classical and modern) on learning and retention, but this manipulation and its effects will be ignored in the ensuing discussion. It suffices to say here that, generally, the music variable did not modify the effects of the stimulus variables.

The stimulus sets presented for learning were generally quite large, often containing between 60 and 80 translation pairs, and within each set a number of the present stimulus variables were orthogonally manipulated. In a few cases (all concerning unpublished studies) smaller sets were used because, within one and the same experiment, the participants had to learn more than one set of foreign words (the reason being that in these studies the music variable was manipulated within subjects, which forced the use of different learning sets in the different music conditions). In all but one of the experiments the complete training session was split up in a number of sub-sessions, each consisting of one or more learning rounds (mostly two) followed by a cued recall test, receptive or productive (but always of the same type in one and the same experiment). In each learning round all PAL stimuli were presented once in a random order on a computer screen, the FL and L1 term of a stimulus appearing next to one another. During testing the recall cue (the FL term of the PAL stimulus in receptive testing; the L1 term in productive testing) appeared on the screen and the participant produced its translation orally or remained silent whenever the translation was not known. An experimenter sat next the participant and noted down the actual response or, when the translation was unknown, a score indicating a missing response.

The number of learning trials per stimulus during a complete training session varied between two and six, it most often being six. Of course, the presentation frequency of a translation pair during training will determine how strongly a new FL word will become rooted in long-term memory. The number of recall

Table 1. Effects of concreteness (Con), cognate status (Cog), typicality (T), and frequency (F) averaged across all recall tests taken during the training session. All effects are given in percentages

Exp	Structure	Con	Cog	T	F	TT	NS	M
HCM	LLT-R	11.0	–	–	–	R	60	–
LG	LLLT1-LLLT2	–	12.4	–	3.6	P	80	–
GK1	LLT1-LLT2-LLT3-R	20.3	16.3	–	–	P	60	–
GK2	LLT1-LLT2-LLT3-R	15.5	18.9	–	–	R	60	–
GK3	LLT1-LLT2-LLT3-R	16.6	–	–	–0.7	P	60	–
GK4	LLT1-LLT2-LLT3-R	16.8	–	–	2.8	R	60	–
G	LLT1-LLT2-LLT3-R	13.5	–	13.6	3.7	R	64	+
U1	LLT1-LLT2-R	16.8	–	15.6	7.7	R	64	+
U2	LLT1-LLT2-R	26.0	16.0	–	–	P	60	+
U3	LT1-LT2-LT3-R (3x)	11.0	–	8.0	8.0	R	3x24	+
U4	LT1-LT2-LT3-R (3x)	12.0	–	6.0	7.0	R	3x24	+
U5	LT1-LT2-LT3-R (2x)	14.4	–	22.0	2.5	P	2x32	+

Exp = experiment (HCM = Van Hell & Candia Mahn 1997; LG = Lotto & de Groot 1998; GK = de Groot & Keijzer 2000; G = de Groot 2006); U1 through U5 = five unpublished experiments; Structure = structure of the experiment (L = a round of learning in which all PAL stimuli were presented once; T = a round of testing, in which either the L1 term or the FL term of all PAL stimuli were presented as recall cue; R = delayed retest about one week after learning). TT = type of testing (P = productive, with the L1 term as recall cue; R = receptive, with the FL term as recall cue); NS = number of different PAL stimuli. Note that U3, U4, and U5 encompassed 3 (U3 and U4) or 2 (U5) sub-experiments in each of which a relatively small stimulus set was trained, a different set in each sub-experiment. M = contains (+) or does not contain (–) at least one condition with background music (in addition to a silent condition, which was always present).

tests during training varied between one and three. We will refer to the recall tests that were taken during the training session as "immediate" tests. In all cases except one (Lotto & de Groot 1998), a "delayed" retest was held about one week after training. No relearning of the new vocabulary prior to this retest occurred. Table 1 provides a summary of the specifics of all 12 experiments: their structure, the stimulus variables that were included, the type of testing, and the number of PAL stimuli in the learning set. A dash in the columns for the four stimulus variables indicates that the variable was not included in that particular study; a value in these columns concerns the effects of that specific stimulus manipulation, to be detailed below.

2. Word-type effects on vocabulary acquisition and retention

In all studies two types of analyses (ANOVAs) were performed on the recall scores obtained during testing (to be included in the analyses a response had to be completely correct; in fact, in the vast majority of the cases in which the participants actually produced a response it was fully correct). The goal of one of these types (the "learning" analyses) was to see how learning developed over the subsequent sub-sessions encompassed by the training phase. In an example experiment with three immediate tests, each following one or more learning trials per PAL stimulus, and with two stimulus manipulations, say, concreteness and cognate status, a 2 (concreteness; concrete vs. abstract) by 2 (cognate status; cognates vs. noncognates) by 3 (tests; Test 1 vs. Test 2, vs. Test 3) would thus be performed. The purpose of the second type of analyses (the "forgetting" analyses) was to be able to determine the extent of forgetting that had taken place in between acquisition and retesting one week later. These analyses were based on the recall scores obtained in the last one of the immediate tests taken during acquisition and in the retest a week later. With this type of analysis we could not only determine the overall degree of forgetting that had occurred in between acquisition and retesting, but also whether different types of words might be differentially susceptible to loss. The forgetting analysis associated with the above example experiment would have been of the type 2 (concreteness) by 2 (cognate status) by 2 (immediate Test 3 vs. the delayed test one week later).

In all studies substantial effects of cognate status, L1 concreteness, and FL (phonotactical) typicality on learning were obtained: The recall scores on the immediate tests were higher for concrete words than for abstract words. Similarly, they were higher for cognates than for noncognates, and higher for typical than for atypical FL words. Across the various studies the magnitude of the concreteness effects, collapsed across all immediate tests taken during training, varied between 11% and 26% (note that the *effects* concern the difference between the percentages correct recall for concrete words on the one hand and abstract words on the other hand). Similarly, immediate recall, collapsed across the various test sessions, was between 12% and 19% higher for cognates than for noncognates, and it was between 6% and 22% higher for typical than for atypical FL words. In contrast to these effects, the effect of L1 word frequency did not materialize in all experiments and, if it did, it was always relatively small, varying between 2.5% and 8%, and was not statistically reliable in all cases. But whenever it occurred, it was in the same direction: Recall scores were higher when the new FL words had been paired with high-frequency L1 words during training than when paired with infrequent L1 words. All word-type effects obtained in all experiments are presented in the middle columns of Table 1.

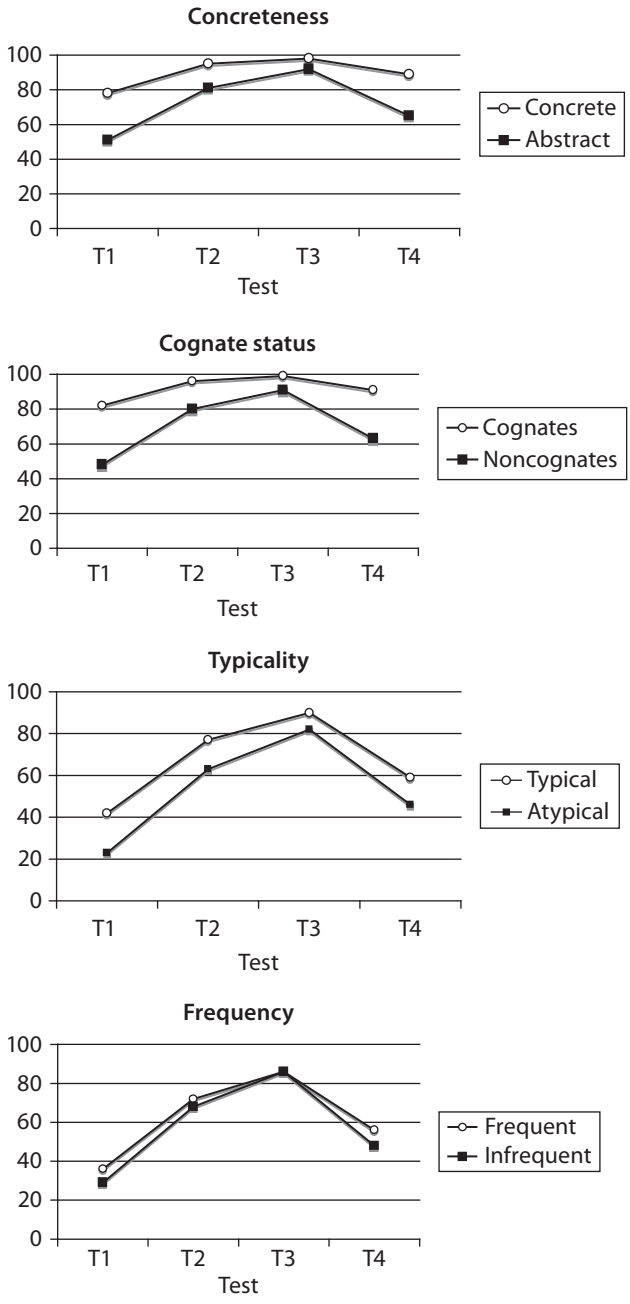


Figure 1. Immediate recall after 2 (T1), 4 (T2), and 6 (T3) learning trials per L1-FL word pair, and delayed recall one week after learning (T4)

Figure 1 shows the recall scores after two (T1; T for Test), four (T2), and six (T3) learning trials per translation pair. It also shows retention one week after training (T4). The data regarding the concreteness and cognate-status manipulations are taken from de Groot and Keijzer (2000); those from the typicality and frequency manipulations from de Groot (2006). They are based on receptive testing (with the FL words as the recall cues) and all scores shown in Figure 1 are representative of those occurring across the different studies. All four word-type variables behaved exactly the same: Their effects are especially large during the earliest stage of learning, after which abstract words, noncognates, atypical FL words, and FL words paired with infrequent L1 words gradually catch up with concrete words, cognates, typical FL words, and FL words paired with frequent L1 words, respectively. A comparison of the recall scores at T3, immediately following the last training sub-session, and at T4, the delayed test, shows that the words with the lower acquisition rates are most susceptible to forgetting: The forgetting functions are relatively steep for abstract words, noncognates, atypical FL words, and FL words paired with infrequent L1 forms during learning. This pattern of differential forgetting occurred in all experiments but two (Experiments HCM and U5 being the exceptions).

3. Explaining the data

3.1 Concreteness and word frequency

The effects of cognate status and FL typicality are intuitively the most obvious, because both concern aspects of the new forms to be learned. The effects of L1 concreteness and frequency are more surprising, because the FL word forms paired with concrete or frequent L1 words during learning do not systematically differ from those paired with abstract or infrequent L1 words, respectively. This observation suggests that knowledge structures that already exist in memory at the onset of learning must somehow cause the effects of frequency and concreteness.

De Groot and Keijzer (2000) suggested two possible causes of the concreteness effects. Both of them assume that differences between the stored meanings of concrete and abstract words in memory underlie the effects, and both are based on the assumption that acquisition rate and retention depend on the amount of information stored in the memory representation of the FL word's translation in L1: The more information stored in the L1 memory representation, the more opportunity the learner has to attach the to-be-learned FL word onto it. One account is in terms of dual-coding theory (e.g., Paivio 1986). This theory assumes two memory representations for concrete words, one in a verbal system and a

second in an image system. For abstract words only a verbal representation is hypothesized. In this set-up, the representations of concrete L1 words provide two points of attachment for the new FL word whereas abstract L1 words provide just one. Note that this account assumes qualitatively different memory representations for concrete and abstract words: the presence of an image representation for the former but not the latter.

The second account only assumes a quantitative difference between the memory representations of concrete and abstract words. It hypothesizes an "amodal" memory system in which all knowledge is stored in one and the same type of information units that do not bear any resemblance with the input that led to their storage, and that does not distinguish between an image and a verbal system. Irrespective of whether the stored information was acquired through, for instance, perceiving an object or reading or hearing about it, the ensuing memory units all have the same format. However, the number of such amodal information elements in memory is thought to differ between concrete and abstract words, the former containing more of them than the latter (Kieras 1978; Van Hell & de Groot 1998). As a result, once again more points of attachment exist for concrete words. A plausible cause for the larger number of stored information units for concrete words is that their referents can be perceived by the senses and that this leads to the storage of information (about the referents' form, color, smell, the sounds they make, etc.). This source of information is not available for abstract words.

A study that has used the "continued free word association" task, where the participants are asked to give as many word associations as possible to each of a series of stimulus words in a certain time unit, has provided evidence that the representations of concrete words indeed contain more information than those of abstract words: More associations per unit time were given to concrete words than to abstract words (de Groot 1989). In this study also slightly more associations were given to frequent words than to infrequent words, although this difference was much smaller than the difference between concrete and abstract words. This finding suggests that the effects of L1 word frequency can be accounted for in the same way: Because the representations of frequent words contain more information elements than those of infrequent words, the former provide more opportunities to fix the FL word forms onto them.

However, a second source of the L1 frequency effects must be considered. The reason a particular word is encountered relatively often in print (or speech) is that it expresses a familiar concept. In other words, word frequency is confounded with concept familiarity and, therefore, concept familiarity may somehow underlie the observed effect of L1 word frequency. Familiar concepts may be stored in denser representations than unfamiliar concepts, so that ultimately again differential information density may cause the effects. Alternatively, equal amounts

of information (numbers of knowledge units) may be stored for familiar and less familiar concepts, but the information stored for the former may on average be more strongly rooted in memory. Plausibly, it is easier to fix new knowledge (i.e., the FL word forms) onto well-consolidated memory structures than onto less stable structures. According to both accounts, just as the effects of word concreteness, the frequency effects would result from differences in the memory representations of different types of words.

3.2 FL typicality

There is evidence to suggest that a specialized component of working memory, the "phonological loop" or "phonological (short-term) memory" (STM), plays an important role in learning the phonological forms (the names) of new words, both native and foreign. The loop is specialized for retaining verbal information over short periods of time and consists of a phonological store and a rehearsal process. The former holds information in phonological form and the latter safeguards the stored phonological forms from decaying for the duration of rehearsal. While the new phonological forms are kept in the store, more permanent memory representations are constructed (see, e.g., Gathercole & Thorn 1998, for a review).

One source of evidence that phonological STM is involved in learning the phonological forms of new vocabulary comes from studies that have shown a relation between the ability of young children to repeat nonwords on the one hand and native and foreign vocabulary acquisition on the other (e.g., Gathercole & Baddeley 1989; Service 1992). In these studies the ability to repeat nonwords served as a signature of phonological STM capacity. Children who were good at repeating nonwords were shown to be better at learning new vocabulary than children performing relatively poorly on the nonword-repetition task. Other support has come from a neuropsychological case study of Baddeley, Papagno and Vallar (1988), in which a woman whose phonological STM was impaired due to a stroke turned out to be completely unable to learn nonwords that were paired with words. Yet further evidence emerges from studies that examined the effect on learning unfamiliar phonological forms of a number of experimental manipulations that are known to affect the workings of the phonological loop. One of these is "articulatory suppression". In a situation of articulatory suppression the learners have to utter a sound (e.g., "bla") continuously during learning. This disrupts rehearsal and short-term storage of the L1-FL stimulus pairs and, consequently, the construction of durable memory representations. Papagno, Valentine and Baddeley (1991) showed that learning under articulatory-suppression instructions resulted in lower recall scores than learning in a control condition where the learners performed a control task (finger-tapping) while learning.

If learning vocabulary requires the rehearsal of new phonological forms, not only the learners' phonological STM capacity should predict learning success, but a relationship should also hold between the "pronounceability" of the learning material and recall scores: New words that are easy to pronounce (and thus to rehearse) should be learned faster and retained better than new words hard to pronounce. Ellis and Beaton (1993) obtained evidence that such is indeed the case: They observed a negative correlation between the time taken to pronounce new vocabulary and recall scores. A similar finding was obtained by Gathercole, Martin and Hitch (in Gathercole & Thorn 1998), who varied the degree of "word-likeness" of the nonwords in a set of word-nonword pairs presented for learning. Wordlike nonwords had a sound structure that resembled the sound structure of the learners' native-language words, whereas non-wordlike nonwords were alien to the learners. Recall scores were higher for the former than for the latter. Both studies thus suggest that the more readily new vocabulary can be pronounced, the more easily it will be learned. It is likely that it is this relationship which underlies the effects of typicality observed in our studies: FL words that obey the phonotactic rule system of the learners' native language (the typical nonwords above) are presumably more easy to pronounce and, thus, to learn than words that do not conform to the L1 phonotactical rule system (the atypical nonwords).

Note, however, that new forms that are wordlike (typical), more so than new forms that are non-wordlike (atypical), resemble the L1 phonological word forms already stored in long-term memory prior to the onset of learning. It is well-known that long-term learning does not exclusively rely on phonological STM but that information in long-term memory is addressed and exploited during learning FL as well (see, e.g., Cheung 1996, and the above account of the effects of L1 concreteness and frequency; and see Baddeley et al. 1998, for a discussion). Plausibly, therefore, the effects of FL typicality are the joint results of the effect of typicality on phonological short-term memory and of the exploitation of phonological long-term memory knowledge during the learning process.

3.3 Cognate status

Vocabulary acquisition is not a "one-shot" process, in which a learning trial either results in full learning of the new word or leads to no stored information on the word whatsoever. Instead, every encounter with a word in speech or print is likely to leave some trace of new knowledge in memory. This incremental view of word learning provides one of two plausible (*not* mutually exclusive) explanations of the effects of cognate status: By definition, cognate translations share parts of their form, whereas noncognate translations have dissimilar forms. The implication is

that in the case of cognate translations there are fewer form aspects to learn than when learning noncognate translations. Consequently, full form knowledge of an FL cognate word will be reached at an earlier moment in time, after fewer acquisition trials, than full form knowledge of a noncognate FL word.

A second explanation locates the effects of cognate status in the retrieval stage and not in the learning process itself: Because of the form overlap between the L1 and FL terms in cognate translation pairs and the absence of form overlap in the case of noncognate pairs, a cognate, but not a noncognate, as recall cue will provide a strong hint as to what its translation might be.

3.4 Differential forgetting

As we have seen, more of the words that were relatively easy to learn were still remembered one week after training than of the words that were relatively hard to learn. In other words, permanent representations were formed in long-term memory for more of the former types of words than of the latter types, despite the fact that all types of words were equally often presented during training. In only two of the 12 experiments (HCM and U5 in Table 1), all types of words were equally susceptible to forgetting. It is noteworthy that both these studies were among those in which the PAL stimuli were presented relatively few times during training (two and three times, respectively). This suggests, perhaps unsurprisingly, that all words, also the easy ones, require a minimum number of learning trials to form a permanent representation in memory and that with a presentation number below this minimum at the most a temporary representation can be formed (see Atkinson 1972, who explicitly makes the distinction between these two types of memory representations). Two further studies in Table 1, U3 and U4, which as U5 presented the PAL stimuli three times during training, *did* show the common pattern of differential forgetting for easy and difficult words. Plausibly, the different forgetting patterns in U3 and U4 on the one hand and U5 on the other hand relates to the fact that the former two used receptive testing whereas the latter used productive testing. Of the two types of testing, productive-cued recall is known to be the more demanding, among others because successful recall requires complete knowledge of the newly learned forms whereas receptive-cued recall requires distinguishable but not necessarily complete knowledge. This suggests that the permanent representations formed for easy words after three learning trials may still be incomplete and that to form complete representations more learning trials are required.

4. Conclusion

At a practical level the present research provides suggestions for the sequencing and rehearsal-frequency of the various types of words in the FL classroom (see de Groot 2006, and de Groot & Keijzer 2000, for details). At a theoretical level it suggests that the initial "labeling" stage of FL vocabulary learning is affected by the information density, strength, and identity of pre-experimental long-term memory knowledge and by the nature of the FL labels: do they promote easy phonological STM coding? Do their phonological forms resemble the phonological knowledge structures already stored in long-term memory? Do they resemble the corresponding L1 translations? Finally, the present research suggests that different types of words require different numbers of learning trials to form permanent (instead of temporary) representations in memory.

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CHAPTER 16

Cerebral imaging and individual differences in language learning

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The majority of the brain imaging studies on bilingualism have focused on the question of the separation or overlap of the neural regions involved when a bilingual brain is working with one language or the other. Researchers have been especially interested in the roles of factors such as age of acquisition of the second language and level of proficiency. In recent studies, however, new questions about the bilingual brain have started to be explored. For example, are there anatomical and/or functional differences between the brains of bilinguals and monolinguals? Do the interindividual differences in the ability to learn a second language correlate with brain differences? We will present recently published and ongoing work about these questions.

1. Introduction

One intriguing observation about second language acquisition concerns the large interindividual variability in second language attainment. The quality of production (accent), for example, varies much more from speaker to speaker in a second language than in the native language. Many factors are likely to be involved, including motivation, age of acquisition, amount of use, etc. (Ellis 1997; Skehan 1989). Some biological factors might also play a role. In this chapter, we describe a few studies conducted in our laboratory that aimed to explore the cerebral correlates of performance in second language.

During the first decade of brain imaging (1995–2005), most studies on the bilingual brain have focused on the issue of whether the two languages of a bilingual recruit the same brain areas or, instead, some language-specific areas as suggested by evidence from brain stimulation (Ojemann & Whitaker 1978). Experiments using positron emission tomography (PET) or functional magnetic resonance imaging (fMRI) compared patterns of cerebral activation associated with the processing of the first (L1) and second (L2) languages as bilingual

individuals accomplished tasks such as reading, repetition or translation of isolated words, naming of images or the comprehension of written or spoken sentences. The majority of such studies described very similar activations for both languages (see Pallier & Argenti (2003) and Perani & Abutalebi (2005) for a summary of the literature involved), a result which is generally interpreted to mean that the same circuits are employed in the processing of either language.[1] Yet, a few studies have described partially distinct activation patterns for L1 and L2, particularly when participants had an intermediate level in the second language (Dehaene, Dupoux, Mehler, Cohen, Paulesu, Perani, van Moortele, Lehericy & LeBihan 1997) and/or had learned it after childhood (Kim, Relkin, Lee & Hirsch 1997).

These observations suggest that the cortical representation of L2, that is to say the areas recruited during use of L2, may progressively overlap with those used by L1 as the learning of L2 progresses. To test this hypothesis, Golestani, Alario, Meriaux, LeBihan, Dehaene & Pallier (2006) used fMRI with ten native French participants who had an intermediate proficiency level in English according to the Test of English as a Foreign Language (TOEFL), and a range of scores on the grammatical subpart of this test (They had learned English in schools between the ages of 11 and 17 and were not using it regularly). While being scanned, the participants had to read lists of words or to construct sentences from the same lists. Subtraction between the activations associated with both conditions confirmed the implication of the left inferior frontal gyrus, Broca's area, in sentence construction (Indefrey, Brown, Hellwig, Amunts, Herzog, Seitz & Hagoort 2001). Within this region, in each participant we localised the point where the cerebral activation linked to sentence construction was at a maximum, in English on the one hand and French on the other. The spatial distance between these activation peaks then served to define the distance between the representations of L1 and L2. Corresponding to the hypothesis of the confluence of Ls 1 and 2, there was a significant correlation between individual scores on the TOEFL test and the distance between activation maxima in English and French: the subjects with the highest scores had the closest maxima. This result suggests that the higher the level of mastery of the second language, at least as far as grammar is concerned, the more similar the cerebral activations associated with sentence construction in L1 and L2 become. Yet, a limitation of this study was that it was based on a comparison between participants having different levels in L2 (cross-sectional approach). To definitely prove that L1 and L2 representations become more similar within the brain of a single individual in the course of language learning, it would

1. It should nevertheless kept in mind that present-day resolution of fMRI images is about 3 mm since it may well be that, at a higher resolution, partial separation between the networks of these languages exist.

be necessary to carry out a longitudinal study in which second language learners would be tested at different time points.

A longitudinal study has been performed by Stein et al. (2009), who scanned foreign exchange students at two time points, 1 and 5 months after their arrival. The task was word reading in L1 and L2. The authors report that, in the first scanning session, L2 words elicited stronger activations than L1 words in frontal regions and that this difference is largely reduced on the second session. This result likely reflects a diminution of frontal control as L2 word identification is becoming more automatized (Hernandez, Li & MacWhinney 2005). Unfortunately, only group analyses are reported and the distances between L1 and L2 activations in individuals were not analysed. Yet, another promising longitudinal study is currently under way at the Max-Planck Institute for Psycholinguistics in Nijmegen where a group of Chinese learners of Dutch are scanned at regular intervals while processing sentences (Indefrey et al. 2004).

The participants in the study by Golestani et al. (2006) described above had learned English in school and did not use it regularly. They had certainly not reached their ultimate attainment in English: should they resume learning it, they would certainly improve in proficiency. By contrast, in the next study, the participants had probably reached their maximum level of proficiency; they were born in a multilingual society (Singapore) and had strong motivations to become highly-proficient in two languages: English and Mandarin Chinese. Nevertheless, there were still non negligible differences in their level in L2, allowing us to compare two groups of people who had grown up in the same bilingual environment but differed in their mastery of the second language (Chee, Soon, Lee & Pallier 2004).

We wondered whether difference in phonological working memory could partly explain the different ultimate proficiencies between the two groups. One expects that an efficient phonological working memory may help in acquiring a second language. The best evidence for this comes from a study by Elizabeth Service, performed on Finnish children starting to learn English in primary school (Service 1992). Scores on phonological memory tasks (memorisation and repetition of Finnish pseudo-words) were measured before the pupils began to learn English; two years later, it turned out that these scores predicted their performance in this new language.

Our Singaporean participants (the high L2-proficient group and the less L2-proficient group) did not differ on measures of phonological memory. However, when we scanned them while listening to a series of French words (a language none of the participants knew) in which they had to detect repeated items, the patterns of cerebral activations of the two groups were different. The group of high L2-proficiency relied relatively more on the regions of the insula and left inferior

frontal gyrus, part of the network involved in phonological working memory, while the less proficient manifested stronger activations in medial frontal areas suggesting a greater attentional effort. A possible interpretation is that those with a better level in their second language used the circuits of phonological memory in a more effective manner. Yet, we cannot be sure that this characteristic was present before they started learning the second language. Again, to obtain a firm conclusion, it would be nice to run a longitudinal study in which subjects were scanned before and after learning the second language.

The experiment we have just described highlighted functional cerebral correlates of the level of bilingualism. Could anatomical characteristics also explain a greater or lesser ability to acquire a second language? We asked this question in the context of the perception and production of phonemes in a foreign language (Golestani, Molko, Dehaene, LeBihan & Pallier 2007 and Golestani & Pallier 2007). For example the contrast between dental and retroflex consonants in Hindi is quite difficult for a French speaker subject to learn. In our laboratory, Narly Golestani trained sixty French volunteers on this contrast and divided them into two groups depending on how quickly they learned to distinguish between syllables using these consonants. We then measured, in each subject, the volumes of the left and right Heschl gyri, structures lying on top of the temporal lobes and housing the primary auditory cortex. Analyses of these data showed that, on average, those subjects with the greatest ability to distinguish the Hindi syllables had a more voluminous left auditory cortex than those who had more difficulties. The volume of white matter differed significantly between the groups, potentially reflecting a greater number or higher myelinisation of the fibres of the auditory cortex in the group of fast learners versus the group of slow learners. It is conceivable that such parameters influence the precision of the temporal representation of sounds which is particularly useful for discriminating consonant contrasts associated with rapid acoustic transitions. A similar result was obtained by Wong et al. (2008) who taught English speakers to distinguish words based on pitch patterns, as occurs in some languages, e.g. Chinese. They report that subjects who were less successful in learning showed a smaller HG volume on the left, but not on the right, relative to learners who were successful. Together with our results, these data confirm that primary auditory regions are important for spoken language learning.

In a follow-up experiment, Golestani & Pallier (2007) assessed the ability of the same volunteers to articulate a foreign sound. We selected a uvular Farsi consonant, easily distinguishable from French phonemes. The subjects were required to produce it in different phonetic contexts and two Farsi speakers evaluated the quality of their pronunciation. Scores thus obtained were correlated with individual probability images of white or grey matter using the voxel-based

morphometry technique. These analyses showed that the accuracy of the pronunciation correlated positively with white matter density in two areas classically associated to phonological memory and articulation, that is, the inferior parietal cortex and the insula (Paulesu, Frith & Frackowiak 1993; Becker, MacAndrew & Fiez 1999; Wise, Greene, Büchel & Scott 1999).

2. Conclusion

In sum, the studies we have presented demonstrate the existence of functional and anatomical cerebral correlates of abilities involved in second language acquisition. These experiments should be considered as first steps in the exploration of a domain which has yet received little attention: the cerebral bases of foreign language acquisition (see also Raboyeau, Balduyck, Gros, Démonet & Cardebat 2004; Golestani & Zatorre 2004; Callan, Tajima, Callan, Kubo, Masaki & Akahane-Yamada 2003). We hope that the future will see more longitudinal studies despite all the methodological difficulties involved (Poldrack 2000).

Finally, it is important to stress that the existence of brain differences between "good" and "bad" learners of foreign language does not imply that the latter should abandon trying to learn a second language. Indeed, even in adults, intensive training can induce cortical modifications which can be detected at a macroscopic level (Draganski, Gaser, Busch, Schuierer, Bogdahn & May 2004; Maguire et al. 2000). Moreover, one study demonstrated that bilinguals have higher grey matter density in an inferior parietal region which may be linked to vocabulary acquisition (Mechelli et al. 2004; Lee et al. 2007). This was true even when the second language had been learned after 10 years of age. One's own brain anatomy should not be an excuse to avoid learning languages! Indeed, analyses of language learning across the life span suggest that it is never too late to learn a foreign languages (Hakuta, Bialystok & Wiley 2003).

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CHAPTER 17

The cognitive neuroscience of second language acquisition and bilingualism

Factors that matter in L2 acquisition – A neuro-cognitive perspective

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In this chapter I aim to systematically discuss the various factors that play a role in the second language acquisition processes that finally lead to what is known as ultimate attainment – from a neuro-imaging point of view. Therefore a basic threefold classification into "biological", "psychological" and "socio-linguistic" factors is tentatively offered. The main focus lies in reviewing recent brain-imaging literature from the relatively young field of "bilingual brain imaging" with the attempt to integrate definitions used in the field of SLA research with the terminology of brain imaging experiments on bilinguals or second language learners. The aim is to put that into a wider framework of second language acquisition by proposing a systematic classification according to which individual differences in L2 learning could better be described. Important factors like, for example, age of onset of learning, proficiency level, experience/exposure, or language aptitude are highlighted and critically discussed.

1. Introduction

Bilingualism, multilingualism, multilinguality, or the possibility of acquiring and communicating in more than one language or dialect, is itself a fascinating and world-wide increasing phenomenon which can be investigated from a variety of disciplines. Within the past few years, partly due to the rising availability of neuro-imaging facilities (functional magnetic resonance imaging, fMRI; Positron Emission Tomography, PET; Electro- and Magneto-encephalography, EEG+MEG) in the field of cognitive science research, imaging the "bilingual/multilingual"

or "second language (L2) learning brain" has become increasingly popular and manifold. Research on the bilingual brain, in terms of medical, neuropsychological or -physiological research itself dates back to older times. It has already been investigated by neurologists in the past century (Scoresby-Jackson 1867; Pitres 1895; Minkowski 1927; Poetzl 1929). Ever since, the most fervidly discussed topic in this area has been the brain organisation of a bilingual/multilingual mind in localizationalist terms.

One of the crucial questions has been: Is there a common store for all languages or are there brain areas, larger networks, or even hemispheres which are specifically dedicated for each of the languages? In case of the latter possibility: Which are these activation patterns in detail and how can the different languages a speaker knows be traced and delineated in terms of brain function? Albeit the huge number of ancient (polyglot aphasia) and recent (brain imaging and neuropsychological) studies (for reviews see: Paradis 2004; Fabbro 2001; Abutalebi et al. 2001; Perani & Abutalebi 2005; Wattendort & Festman 2008; De Boot 2008; Indefrey 2006; Kotz 2009) the investigation of these questions has brought forth, there is still little consensus as to the exact nature of bilingual language representation, retaining it an issue of ongoing controversial debate. The results so far can be subsumed under 3 major viewpoints. There is (1) the common storage viewpoint which claims a more or less precisely defined common network being responsible for the handling of all languages a speaker knows (e.g. Ojima et al. 2005; Illes et al. 1999; Klein et al. 2006). The opposite view (2) could be called "multi-center-storage" or "multi-center-processing" view, which, in its extreme form would assign each language an own processing entity in the brain (most commonly this would be a different area or a different network responsible; e.g. Kim et al. 1997; Dehaene et al. 1997; Rodriguez-Fornells et al. 2002). There is also a moderate view (3), which could be termed the "partial overlap" view. According to this view only some areas show common activations for processing L1 (first language or mother tongue) and L2 (second language) and additionally other areas get activated by the L2 (L3, L4) only (e.g. Vingerhoets et al. 2003; Marian et al. 2003; Chee et al. 2003; Lucas et al. 2004). This third view could be seen as having a second variant: the "core overlap / additional extension" view. Under this viewpoint one could subsume all studies (e.g. Gandour et al. 2007; Hasegawa et al. 2002; Reiterer et al. 2005a, b; Liu et al. 2010) which found a basic core overlap for L1 and L2 processing, with the extension of additional brain tissue (surrounding the core areas) being activated by the L2s, possibly as a function of fluency (see also caption 'proficiency level'). It is therefore still difficult, at the time being, to draw final conclusions about the exact nature of brain organisation of a bilingual/multilingual's mind. On a theoretical-conceptual basis, one could criticize the terminology used, or state that the basic research question about the special status

of "bilinguals" is ill-posed. The fact that "second language acquisition" is treated as something completely distinct from "first language acquisition" (assumption of a qualitative difference between L1 and L2) perhaps draws borders where there are none. If we assume a basic innateness to language acquisition for humans, encoded in genetic material and expressed and enacted by the brain, we should not treat different types of "language acquisitions" differently, but assume that they all follow more or less the same biological principles. The "common storage" principle (1), the emerging picture that is drawn by the above described brain imaging research, points in that direction. In so far, it would be more convenient for language acquisition research generally to view all language learning on one continuum, regardless whether it concerns "first", "second", "third", or "whatever" language/code learning – and see language learning as the incorporation of codes into one personal communicative space of a speaker. By learning new varieties or registers even in the framework of one's mother tongue, a person continuously enlarges his or her personal "communicative space". Incorporating knowledge about a "second language" seems qualitatively similar to incorporating a different "register" in one's first language system. The system gets enlarged over time, some features are added anew, some build upon pre-existing ground. This mechanism could be an explanation for the process that we see reflected in numerous brain imaging studies of so-called "polyglot" speakers (common storage, but additional area recruitment only on demand). In a recent meta analysis of the literature of brain imaging experiments to this question (Indefrey 2006), the authors came to the conclusion that the majority of studies did not find differences (the "common storage view") between L1 and L2s, but those who did find them, found them reliably within the same areas, however, only for subgroups of bilingual speakers (depending mostly on proficiency level) and predominantly in the direction of stronger activation during L2 processing.

However, there are other possible explanations for the difficulty of not being able to draw decisive conclusions about the state of the art of the "bilingual brain". One of the possible explanations why conclusions are difficult to draw and why the overall results are confusing, could be the simple fact that too many uncontrolled factors are in play. Confounding factors which can influence brain activation and cerebral processing of language(s) are on the one hand of a language-internal nature and regard primarily the design of the study and stimulus material. Sentence or text processing will affect brain organization differently than language processing on the word or syllable level, and yet other areas will be involved according to the computational language processes that are in question, e.g. production versus perception. Further differentiations regard the modularity of language (e.g. semantic, lexical, morphological, syntactic, phonological, articulatory, pragmatic levels). Most of the brain imaging studies conducted on bilinguals so far contain

a variety of different stimuli and study designs, rendering comparability of results difficult (for review on bilingual studies according to different study paradigms see Guillberg & Indefrey 2006; Indefrey 2006).

The second and even bigger source of confusion results from the intricate nature of the language acquisition process itself, which, for each person, each social group, each language, each linguistic subsystem and each situation, can be intra- and inter-individually different. This group of factors is even more difficult to control for, because it would require rigorous collateral psychological testing and behavioural questioning, which in addition to elaborate brain imaging or biometric experiments is often highly time-consuming and faces practical limitations, given the amount of potentially influencing factors.

2. Factors that matter

As with every developmental process in nature, there are biological (nature) as well as environmental (nurture) factors in play which determine and shape the exact pathway of development and the outcome or success of the process, which, expressed in L2 terminology could be called: ultimate attainment or level of proficiency reached. These factors influencing second language learning and acquisition will leave traces in the form of differential brain activation patterns in "different" bilinguals. Developing a simple dichotomy reflecting the above mentioned nature/nurture distinction for the sake of grouping these factors systematically (e.g. biological versus social), seems intuitive, but remains problematic. Grouping biological factors (nature part) influencing bilingual brain organization seems straight forward. Here I would like to include: DNA, sex, handedness and age (as a consequence of brain maturation, changes in plasticity). On the nurture side socio-cultural or linguistic factors would comprise: manner of acquisition / teaching method, amount and quality of input/training, exposure time, purpose of language use and linguistic environment, language attitudes of social group and individuals, exposure to or experience of bidialectalism and polyglottism (e.g. number of languages or registers spoken or heard, code switching habits), language type itself and linguistic subsystems (for L1 and L2). The problematic factors which can neither be called purely "nature" nor "nurture", are what I would term "psychological" factors: motivation, learning strategies/styles, domain general cognition / executive functioning / language control, intelligence/verbal intelligence, memory capacity (working memory), personality (e.g. anxiety, extraversion, empathy) and language learning aptitude/talent/ability – a factor which only recently is gaining a revival of attention (Amunts et al. 2004; Golestani et al. 2007a, b; Diaz et al. 2008; Barry et al. 2009; Dogil & Reiterer 2009). It is questionable in how far

these psychological variables are influenced by "nature" and are therefore rather predispositions, requiring renaming as "psycho-biological", or, by "nurture" – i.e. environment and experience. This touches on a currently heated debate amongst neuroscientists, or scientists in general, 'how "hard wired" and bio-chemical is the human mind/psyche?' (e.g. Mohr 2003). However, the division into "biological", "psycho(bio)logical" and "socio-cultural-linguistic" should be sufficient to comprise all possible influencing variables.

2.1 Psycho(bio)logical factors influencing bilingual brain organisation

In the case of bilinguals, multilinguals and second language learners, little is known about the implications that motivation, individual learning styles or strategies, (verbal) intelligence and personality have on their language related brain organisation. However, some psychological aspects relating to bilingual language capacities have already been investigated with brain imaging techniques, e.g. executive functioning, cognitive control, working memory and language ability/aptitude. With regard to executive functioning, Bialystok et al. (2005) investigated the effects of bilingualism on executive functioning and found that bilinguals develop higher levels of cognitive control, which again is reflected in their differential activation of left temporal, superior and inferior frontal areas and cingulate cortex. Executive functions, like language control are also necessary for the phenomenon of "language switching", which, in some form, is always employed by bilinguals. The phenomenon itself has been approached by several brain imaging studies, pointing either to a sub-cortical involvement (Abutalebi et al. 2000) or in most cases even to an increased involvement of non-language specific areas, like the prefrontal cortex (Hernandez 2009; Rodriguez-Fornells et al. 2005; Price et al. 1999; Hernandez et al. 2000).

Investigating nonfluent bilinguals on a verbal working memory task, Xue et al. (2004) found increased activations in a left dominated fronto-parietal network for the L2. An fMRI study by Chee et al. (2004), investigating phonological working memory in both, equal and unequal bilinguals, revealed more activation within the left insula and Broca's area as well as less activation within the anterior cingulate for the equal bilinguals and less anterior cingulate activation for the unequal bilinguals' group. They suggested that these patterns of differential activations show that more optimal engagement of phonological working memory in the group with higher language proficiency correlates also with better second language attainment and discussed the terms "language attainment", "higher language abilities". Recent functional brain imaging research (Nauchi & Sakai 2009), indicated that the syntactic abilities of L2 speakers (independent of their lexical

knowledge in L2) determine the strength of leftward lateralization of the inferior frontal gyrus (pars triangularis).

In a series of structural brain imaging studies using a phonetic learning paradigm of novel speech sounds, certain brain structures, primarily the left inferior parietal area, could be correlated with success (speed) of phonetic learning (Golestani et al. 2004, 2007a). The authors summarized that brain anatomy itself could predict the success in learning foreign speech sounds. Exactly the same left parietal area has been found also by other researchers (Mechelli et al. 2004), investigating the influence of age of acquisition versus "proficiency level" in L2, to correlate with higher fluency levels (and lower age of acquisition) in bilinguals. In the beginnings of the 20th century this left inferior parietal area has already caught the attention of a neurologist (Poetzl 1929) as being in some form connected to the phenomenon of foreign language learning talent. A neuroanatomical study (Amunts et al. 2004) explicitely investigated exceptional language talent in an interpreter who was known to have spoken over 50 languages fluently. By looking at the cytoarchitecture of his conserved brain slices they revealed significant differences between this outstanding language talent's cell structure in Broca's area as compared to normal reference brains. Consequently, two major streams of interpretation are possible here. First, language aptitude, or the ability for enhanced (in speed and ease) uptake of a high number of foreign languages (hyperpolyglottism) could influence, act upon and alter brain function as well as structure (plasticity), and, the second possibility – the reversed case – that brain structure determines the amount or relative level of language aptitude/ability in an individual. Generally speaking, the truth most probably lies in the golden middle, which would predict a constant and life-long intricate interplay between nature (our genetically pre-wired brain, "giftedness") and environment (events triggering experience with language and thus "learning") – eventually resulting in language learning talent and expertise.

2.2 Linguistic factors influencing bilingual brain organization

In a study by Proverbio (Proverbio et al. 2002) the factor polyglottism as an influencing factor has been brought into play. Showing that multilinguals differed in their hemispheric activation patterns for semantic and syntactic processes lead the researchers to the conclusion that multilinguality could be one of the most powerful predictors of bilingual brain organisation.

Furthermore, language type (Klein et al. 1995; Chee et al. 1999; Ruschemeyer et al. 2005; Tham et al. 2005), grammatical complexity (Yokoyama et al. 2006), orthographical transparency (Meschyan et al. 2006) as well as difference in linguistic

subsystems (semantic vs phonological; Marian et al. 2003; Pillai et al. 2003) all have been claimed to have their specific influences on the brains of speakers of more than one language. For a recent large-scale historical as well as interdisciplinary (including recent brain research) survey on hyperpolyglottism (outstanding language learners) see Erard (to appear 2010).

2.3 Socio-cultural factors influencing bilingual brain organization

Little is so far known about the issue and influences of language attitudes on brain functioning. A few decades ago manner of acquisition / teaching method (informal "acquiring" versus formal "learning") was a heatedly discussed issue which lead to speculations about the differential engagement of the hemispheres (either more left or more right) for either the formal or the informal modes of learning (Vaid & Hall 1991; Reiterer et al. 2009). Purpose of language use, or, the impact of linguistic environment was investigated by Evans et al. (2002) with the resulting observation that lateralization in bilinguals is strongly affected by the specific language environment during development, reflected in more RH (right hemisphere) involvement for the later learned language in bilinguals brought up in areas where this language is not regularly heard. Closely connected to language environment is the concept of exposure time, which was singled out as an important variable affecting the brain patterns in bilinguals, even in the case that both languages were acquired early and with a comparable level of proficiency (Perani et al. 2003). Not informal, but formal exposure time was the subject of recent EEG studies by Reiterer et al. (2005a, b, 2009). The researchers measured the impact of amount of high-level linguistic university training in a second language on the electrical brain synchronization patterns of university language students (L2 English; L1 German; age of onset 9 years for both groups) versus non-language students with much lower amounts (5 years difference) of formal English instruction and exposure. Results revealed characteristic differences in the alpha synchronization patterns for the groups during all language processing tasks, irrespective of the stimulus language (L1 or L2). The group with high amount of training displayed focal synchronization patterns only over specific electrode pairs of the left temporo-parietal areas in addition to a significant decrease of synchronization (against baseline) in bilateral prefrontal areas. The low training group showed widespread synchronization increases covering the entire left and partly also the right hemisphere. The results are discussed within an efficiency of processing paradigm (cortical efficiency; core overlap / partial extension view) differentiating between higher and lower levels of proficiency.

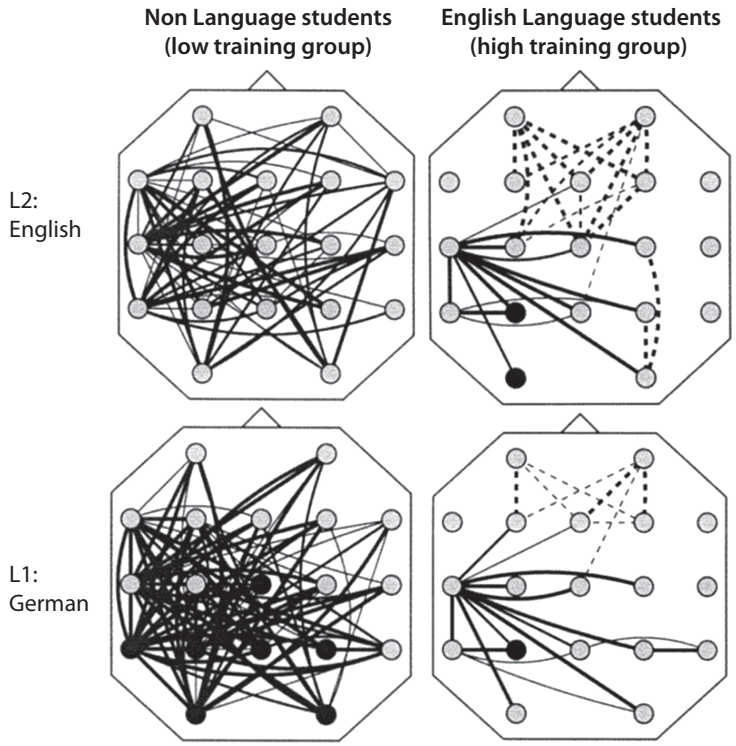


Figure 1. EEG alpha (8–12 Hz) brain maps: Left column: Non language students (low proficiency group), right column: English language students (high proficiency group). Upper panel: L2 English, lower panel: L1 German. Bold lines represent synchronization increases between electrode places; dotted lines synchronization decreases (against a baseline task, e.g. looking into grey flickering screen).

Since the (generally attention-sensitive) alpha synchronization patterns did not discriminate along the languages, but the groups, the authors followed that either highly advanced and long-term language training at university (5–6 years) backpropagates on, reshapes or refines also the processing habits of the first language (resulting in generalized language processing strategies), or language ability, aptitude or pre-existing factors could be in play which differentiated the groups beforehand. In general, it is still an open question whether the observed brain differences in imaging studies result from genetic predispositions triggering enhanced language ability, or from structural reorganizations induced by language experience. For clarification more future research into this intricate issue is needed.

2.4 Biological factors influencing bilingual brain organization

Evidence for a possible link between genetic predisposition (DNA) and first language learning is by now abundant (e.g. Bishop 1999, 2006; Fisher & Francks 2006; Lieberman 2009) and it is becoming clear that there is strong evidence for an 'innate component' in language learning as being rudimentarily but strongly rooted in genes and successive brain development. However, such research connected to second language acquisition is still scarce, but a logical step towards further research, if one assumes no qualitative difference between L1 and L2. Some indirect evidence of the genetic influence on L2 comes from studies on bilingual down syndrome children, who display the same language difficulties for L1 and L2 (Bird et al. 2005), and from a twin study by Sakai et al. (2004) who found influences of grammatical L2 learning on the left dorsal inferior frontal gyrus, correlated in twins, concluding that a cortical mechanism underlying L2 acquisition also critically depends on shared genetic, not only environmental factors. Among other biological factors like sex and handedness (Andreou et al. 2005; Friederici et al. 2008), most of the attention within brain imaging of "second languages" has been drawn towards the factor of age of acquisition (AOA). If coinciding with supposed critical or sensitive periods in brain development and loss of cortical plasticity, AOA is believed to play a major role in qualitatively distinguishing between L1 and L2 by affecting the brain processing efficiency of languages learned after that period in life in a way that is detrimental and inhibitory to native speaker-like performance in late second language acquirers and learners. The vast amount of literature that has been written on that topic cannot be sufficiently reviewed here (for review see, for example, Birdsong 2006; Wattendorf & Festmann 2008). A glance at the brain imaging studies that have been conducted to that question so far gives the impression that there are at least as many studies in favour (e.g. Kim et al. 1997; Perani et al. 1996; Wartenburger et al. 2003; Mechelli et al. 2004) as against (e.g. Perani et al. 1998; Ojima et al. 2005; Friederici et al. 2002) age as being "the" ruling organizing principle in a bilingual's brain. In fact, in a recent review on this question (the age of onset versus proficiency debate) for syntactic acquisition brain imaging studies, Kotz (2009) concluded that age of onset (or a critical period) does not determine, at least, syntactic L2 acquisition.

The fact that "the critical age" issue has stirred so many persisting speculations does not mean that it is the only influencing principle in bilingual brain organization. It was perhaps just amongst the first factors which were successfully explanative and amongst the most appealing because of ease of 'operationalizability' as an influencing variable in contrast to 'proficiency' as an influencing factor. However, proficiency level recently seems to have taken the lead and is amongst,

if not at the time being, the preferred variable because of its explanatory power. (compare Kotz 2009; Indefrey 2006; Green 2003).

3. Proficiency level – Concluding remarks

In fact, many studies looking at the brain organization of bi-or multilinguality, with or without explicitly investigating proficiency level, found in level of fluency explanative power (Yetkin 1996; Perani et al. 1998, 2003; Chee et al. 2001; Briellmann et al. 2004; Xue et al. 2004; Mechelli et al. 2004; Tatsuno & Sakai 2005; Reiterer et al. 2005a, b). A psychological concept, less well known within bilingualism research, which has already been coined as a term as early as four decades ago (Ertl 1969), called the 'theory of cortical efficiency' can explain many of the results obtained from studies on proficiency level as discriminating brain activations of bilinguals. This neuropsychological theory predicts that higher amounts and more distributed forms of brain activation go hand in hand with lower levels of performance in skills, lower expertise, (not necessarily only but also applicable to language processing as well as second language learning; Haier et al. 1992; Just et al. 1996; Hasegawa et al. 2002). However, a word of caution should be said about the term proficiency level itself.

Conceptually speaking, proficiency level is a misleading term. The explanative power it consists of, could in part be explained by the fact that proficiency level is not a singular or 'pure', but complex factor, which functions as umbrella term and subsumes many of the other factors which have been mentioned above (like: biological, psychological, socio-cultural, linguistic etc.). Proficiency level can neither be regarded as biological, psychological, social nor linguistic factor because it is the sum of all. It is the measure or the outcome of the phenomenon of language learning itself, the acquisitional process measured at any given point in time. Albeit its widespread usefulness, it is strictly speaking a fuzzy term for investigating the phenomenon of bilingualism in the brain, because it is a sum factor reflecting the phenomenon itself, not a variable that contributes to it. Because of this, the direct comparison between – "age of onset" versus "proficiency" – what contributes more? – is flawed. It is like comparing a "token" to its "type": "age of onset" being the token, a single biological parameter/factor that can contribute to the overall outcome, and "proficiency" being the type, namely, the overall outcome itself, which is the ultimate proficiency level of a second language speaker – and therefore comprising all the aforementioned factors. Since proficiency level is too broad as a variable (umbrella term) and therefore too all-inclusive, it probably easily explains the results of most imaging experiments on bilinguals. This is of course convenient and positive in the first place, but lacks precision and masks

"true explanation" of the phenomenon. For clarifying the issue and for future experiments, I would suggest to use more precise terminology for and single out the variables that cause or lead to individual differences in "proficiency level" of an L2 speaker. The single "basic variables" or components could be, for example, "time of exposure", "age of onset", "extent of training and experience", or "language aptitude/ability". Basically, individuals might gain high proficiency levels, because of three main variable-complexes: a "training/experience/exposure"-complex, a pre-existential "ability/aptitude/talent"-complex and a "time-window/plasticity/age"-complex, mediating between the two other components. What could be done to improve clarity in imaging experiments is to excavate the provenience of the variable and denote it as precisely as possible, like in, "proficiency level by training", "proficiency by aptitude", "proficiency by early onset", "proficiency by high exposure", or combinations thereof, "proficiency by high exposure plus aptitude" and so forth.

This and other terminological issues (like that of the terms "bilingualism"/"second language acquisition"/"second language learning") often give rise to confusion, possibly because of lack of interdisciplinary integration between the fields of brain imaging and neuroscience on the one hand, and second language acquisition, applied linguistics and theoretical linguistics on the other – a fact which calls for more joint efforts of neuroscientists and language researchers to build new links for paving a common ground for future projects at this border between two areas of research.

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