

FELT TIME

The Psychology of How We Perceive Time

MARC WITTMANN

translated by Erik Butler

Felt Time

Felt Time

The Psychology of How We Perceive Time

Marc Wittmann

translated by Erik Butler

The MIT Press
Cambridge, Massachusetts
London, England

This translation, © 2016 Massachusetts Institute of Technology

Originally published as *Gefühlte Zeit* by Marc Wittmann, © Verlag C. H. Beck oHG, Munich 2014

All rights reserved. No part of this book may be reproduced in any form by any electronic or mechanical means (including photocopying, recording, or information storage and retrieval) without permission in writing from the publisher.

Library of Congress Cataloging-in-Publication Data

Names: Wittmann, Marc, author.

Title: Felt time : the psychology of how we perceive time / Marc Wittmann; translated by Erik Butler.

Description: Cambridge, MA : MIT Press, [2015] | Includes bibliographical references and index.

Identifiers: LCCN 2015038278 | ISBN 9780262034029 (hardcover : alk. paper) | ISBN 9780262333870 (retail e-book)

Subjects: LCSH: Time perception. | Time—Psychological aspects.

Classification: LCC BF468 .W57 2015 | DDC 153.7/53—dc23 LC record available at http://lccn.loc.gov/2015038278

EPUB Version 1.0

Contents

Acknowledgments
Introduction
1 Temporal Shortsightedness: On Being Able to Wait
2 Looking for the Rhythm of the Brain
3 In the Moment: Three Seconds of Presence
4 Internal Clocks: What We “Need” Time For
5 Life, Happiness, and the Ultimate Time Limit
6 Winning and Losing Time: The Self and Temporality
7 Body Time: How the Sense of Time Arises
Notes
Image Credits

Acknowledgments

My research at the Department of Psychiatry at the University of California, San Diego, began in October 2004 with a stipend from the Max Kade Foundation in New York, which enabled me to spend a year at the lab of the psychiatrist Martin Paulus. This contact was arranged by Franz Vollenweider, a psychiatrist at the “Burghölzli,” the Psychiatric University Clinic of Zurich, with whom I had conducted a research project on the effects of hallucinogens on temporal perception.

A new stage of research, based on many discussions with Martin Paulus and Alan Simmons, began in La Jolla, near San Diego. Given the structure of the German university system, my scientific career would have been over had the stipend not been granted. One year in San Diego turned into five. In the course of research conducted during this period, from 2004 to 2009, the thesis emerged that temporal experience depends on emotional and bodily states. We were able to show that bodily sense, emotions, and the sense of time are all closely tied to the activities of a structure in the brain, the insular cortex. I am indebted to Martin Paulus and Alan Simmons for support in performing and interpreting studies conducted by means of functional magnetic resonance imaging. Moreover, I received support for programming from Jan Churan. The success of my stay was assured by grants Martin Paulus and I obtained from two third-party sources. The National Institute of Health NIH/NIDA and the KAVLI Institute for Brain and Mind, San Diego, backed the project financially.

I was also able to develop my ideas about how the brain represents time through ongoing collaboration with Virginie van Wassenhove (then at the California Institute of Technology, now at the Cognitive Neuroimaging Unit INSERM-CEA, Paris) and A. D. (Bud) Craig of the Barrow Neurological Institute in Phoenix, Arizona. Bud Craig is the first researcher, drawing on understanding of the neuroanatomic and neurofunctional bases of bodily sense, to have advanced the thesis that the insular cortex is the decisive neural structure for the feeling of time.

My research on the phenomenon of time began earlier, first as a research

assistant and then as a degree candidate working for Ernst Pöppel at the Institute of Medical Psychology at the Ludwig Maximilian University of Munich. Professor Pöppel, who oversaw my PhD in 1997 and my Habilitation in 2007, has always been a mentor.

From 2000 to 2004, I directed the research group “Time and Cognition” at the Generation Research Program, Bad Tölz, of the Ludwig Maximilian University. Martina Fink, Jan Churan, and Pamela Ulbrich were part of the team who developed test procedures and obtained funding for two projects from the Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung, BMBF). Two proposals submitted to the German Research Foundation (Deutsche Forschungsgemeinschaft) were rejected. During the same period, Tanja Vollmer and I also pursued another project: “Time Perception in Patients Near Death.” The study was conducted at Medical Clinic III at the Clinic Grosshadern and was financed by the Else Kröner-Fresenius Foundation.

Since October 2009, I have been employed at the Freiburg Institute for Frontier Areas of Psychology and Mental Health (IGPP). Thanks go to Jiří Wackermann who invited me to come and work at the IGPP Freiburg, where I continue to focus on developing concepts of time perception and finding new fields of application. Important professional contacts and collaborators for the current studies include Karin Meissner (Institute of Medical Psychology) at the Ludwig Maximilian University of Munich, Niko Kohls (University of Applied Sciences, Coburg), Stefan Schmidt (University of Freiburg), and Anne Giersch of the Psychiatric University Clinic Strasbourg. In Freiburg I have been funded by two grants from the BIAL Foundation in Portugal as well as by the trinational neuroscience network NEUREX of the Upper Rhine Valley. I have also been supported by the European project COST ISCH Action TD0904 “Time in Mental Activity: Theoretical, Behavioral, Bioimaging, and Clinical Perspectives” (TIMELY). Thanks go to Argiro Vatakis who started and managed this network activity for researchers in the field of time perception. I benefited enormously from countless exchanges with like-minded colleagues.

Chapters of this book were read by my colleagues, whose expertise yielded valuable suggestions: Isabell Winkler, Dorothe Poggel, Karin Meissner, Katya Rubia, Evgeny Gutyrchik, Tanja Vollmer, Jakob Pacer, Niko Kohls, and Martin Paulus.

In addition, I received criticism and encouragement from friends who read the

manuscript very attentively: Katharina Weikl, Jochen Rack, Klaus Meffert, and, of course, Oksana. Thanks go to my mother for helping me edit the English translation.

Years ago, I told my friend Dirk Thiel that I was looking for the internal clock governing the perception of time. His response was curt: “That’s obvious: the heart.” I didn’t believe so then, but he might be right.

Introduction

This book is about the perception of time. It concerns our subjective feeling of the passage of time and our sense of duration. Ever since human beings first became self-aware, the phenomenon of time has posed a riddle. What is subjective time? How does our sense of time come about?

However, the book does not just ask questions. It also offers many answers, explaining how our feeling of time arises—whether for a moment or in terms of life as a whole. In recent years, scientists have made an array of discoveries that, taken together, yield a new picture of subjective time. Through patient efforts, researchers have accumulated psychological and neuroscientific insights that provide a new—and, more importantly, a convincing—answer to the age-old question of how we become conscious of time.

If time is the thread running through this book, the matter involves many fundamental processes anchored in daily life. Time comprises a net in which phenomena suddenly appear in a wholly different light. These phenomena include feelings, memories, happiness, language, scholastic and professional achievements, one's sense of self, consciousness, stress, mental illness, and mindfulness of one's own self and body. The net of time involves, among other things:

- Why time speeds up as we grow older: increased routines in life and memory play decisive roles.
- How a fulfilled life depends on our ability to choose freely between savoring the moment and deferring gratification; why impulsive people are more easily bored is a matter of time.
- Whether every person has a particular brain rhythm that sets quicker people apart from slower ones—an object of scientific research; does the brain rhythm speed up in fearful situations?
- What we actually "need" time for—judgments about time often serve as error signals indicating that something is taking too long or was much too

short: this is important for everyday decision making.

- Whether it is possible, through mindfulness, to reduce the speed of life we perceive and thereby gain more time; meditation is one way to slow down subjective time.
- How emotions and our senses of time and body are strongly related; evidence is accumulating on how body signals are part of our experience of existing in the “here and now” and provide the basis for feeling the passage of time.
- The functions of brain systems that underlie our experience of time and the conscious self; ongoing studies on time consciousness will help us better understand the conscious self.

What does a fulfilled life look like? Ultimately, the way we manage the dimensions of our past, present, and future proves decisive in this. One way of putting it is: we must accept the past as it is. What is past can no longer be changed, but one can learn from experience to better face the present and future. It is not by chance that personal unhappiness often derives from unwillingness to come to terms with the past, when we cannot let go. We also tend to worry too much about the future and develop exaggerated ideas about what could happen. Yet we are always living in and experiencing the present. Accordingly, our task is to cultivate presence. What belongs to the past and future always bears on the lived presence that we are experiencing—now.

It is worthwhile to take a closer look at the dimension of time, for it is inseparably tied to our experience as a whole, to our self-consciousness—to life itself.

We are time.

What precisely this means, the following pages seek to show.

1 Temporal Shortsightedness: On Being Able to Wait

Children often have trouble waiting. They experience a strong urge for their wishes to be fulfilled immediately. However, delaying gratification, which involves a period of waiting, often proves more useful in the long term. The famous “Marshmallow Test” has demonstrated, to dramatic effect, how children’s management of waiting periods determines success in school and social situations. All the same, focusing on the present is not negative per se. People who painstakingly attend to every entry in their calendar—and, in so doing, remain trapped by their anticipation of the future—sacrifice their potential to experience lived time.

When the results of a scientific study appear as a special feature in a daily newspaper, it is an indication of their importance. On September 10–11, 2011, the *Süddeutsche Zeitung* reported an item of note: crows and ravens will rein in their immediate desire to eat a piece of food when they know they can receive better food by waiting. The article relates how these birds, which have a reputation for unusual intelligence, can learn to forgo food that is only somewhat appealing when they have the prospect of receiving other, more appetizing fare within a period of up to five minutes.[1]

Children are raised not to pounce on food right away when they are hungry. We can wait the appointed time for a family meal instead of raiding the refrigerator. Just as corvids will observe a waiting period, we are able to spend an hour or more making our food better by baking or cooking it; we wait and get a better meal. In more general terms: when it is a matter of accepting a reward of lesser value or, alternatively, getting a bigger reward in exchange for waiting, the decision is often to wait—provided that it pays off. Human beings are able to anticipate temporal duration and integrate into their decision making their assessment of the time they will probably need to wait. Research on pigeons, chickens, and even monkeys has shown that these animals can put off rewards only for a few seconds; they prefer food right away, even when it is of lesser quality. Only great apes, such as chimpanzees, had been known to accept delays of several minutes when given the opportunity to get more treats. Now we know

that ravens and crows do the same.

Apart from food intake, which represents a primary need, human beings learn to delay the fulfillment of needs in many circumstances of life. When employees make a monthly contribution to retirement accounts and, in so doing, forgo the immediate use of their money, they do so in order to be able to draw on the funds decades later, when they are no longer working. In general, many aspects of culture are based on the principle of deferring gratification. Months or years of hard work performed by individuals provide the basis for the cultural achievements of society as a whole. Thus, to write a book, an author must give up free evenings and weekends, sacrificing the comfort and pleasure of meeting with friends—or just watching TV. Countless examples exist of the choices we face to either have a good time now or work for greater returns later on. Given the significance of deferred gratification for rewards on a social scale—to say nothing of individual success as a member of the community—it is not surprising that parents vex their offspring with rules such as “Do your homework, *then* you can go outside and play.” But for all that, self-determining adults have to contend with the same kind of decisions about how to use their time. For example, should one go for a jog to stay in shape (given that fitness depends on sustained efforts over the long term), or would it be preferable to enjoy a glass of wine on the couch while reading the paper?

A famous study conducted by the American psychologist Walter Mischel demonstrated the importance of being able to make time-based decisions for success in life.[2] The most remarkable feature of the study is that it occurred over an extended period: more than five hundred children between the ages of four and five were tested initially; then, after ten years—when they were adolescents—further research was performed. In the initial experiment, the children were given candy. The examiner told them: “If you want, you can eat the marshmallow right now. It belongs to you. But if you can wait a little, until I come back, you’ll get another marshmallow, and you can eat that one, too. But you only get the second marshmallow if you don’t eat the first one.” The examiner then left and returned ten minutes later. In the interim, the children were observed or filmed. What happened made it possible to draw many conclusions about the strategies they used to pass the time and distract themselves from the candy. Responses varied enormously. Some children ate the marshmallow right away. Others proved able to wait a while, but they eventually took nibbles—meant to pass unnoticed—until the marshmallow disappeared

entirely. Some children even managed to wait out the allotted period. Ten minutes alone in a room without any distractions (e.g., the magazines one finds at a doctor's office) seem long even to an adult. The children who managed to wait would sing songs, play peek-a-boo by themselves, or start thinking aloud. They developed strategies of diversion.

A decade later, for the follow-up, one hundred of the children could still be located. Their performance in school was determined on the basis of standardized college-admissions tests, and parents also assessed their social and scholastic abilities. A moderate yet clear correlation emerged: the more time they had been able to wait before eating the marshmallow at the age of four or five, the better their scores turned out on tests ten years later; they did correspondingly better, in their parents' judgment, in terms of schoolwork, social interaction with peers, and dealing with frustrating events. "Scholastic performance" and "social competency" are two important categories for success or failure in our society—this is hardly surprising. The findings are noteworthy, however, in that ten years lay between the two occasions when aptitudes were assessed, and in the course of developing from a child into a young adult, one is exposed to many different influences. Even though a significant interval had elapsed, the Marshmallow Test could predict success in school and life to a notable degree.

That said—and the figures from the original publications should be consulted on this point—it must be stressed that the correlation is moderate at best; many other factors contribute to scholastic success and social skills. But all the same, a connection holds between the capacity to wait longer for the second marshmallow and the ability to handle tasks of life in the course of further maturation. With due caution, then, we may affirm: the ability to exert oneself for a certain period of time pays off in the long run. Such children have an easier time doing homework, and they deal better with the frustrations of social rules that parents and teachers impose. Frustration tolerance means being able to handle unpleasant situations in life more readily. In this context, we may call it *emotional intelligence*,[3] that is, the successful management of one's feelings, which involves understanding that an effort now is required for gains later on. One might also call it foresight.

Significantly, the children did not differ much in terms of other important factors. Members of the group in the initial study had similar sociocultural backgrounds, as well as comparable intelligence levels; for the most part, the

subjects came from academic families at Stanford University. This makes it clear, yet again, that intelligence is joined by other factors—for example, the capacity for frustration tolerance—for determining success in life.

Temporal Myopia

The results of the study may be taken to demonstrate that the children who succeeded in the Marshmallow Test had a broader temporal horizon. Conversely, children who proved less successful in the test were more present oriented. Apropos of this test of deferred gratification and others like it, we have an expression that describes when people have the possibility of receiving a greater reward at a temporal remove yet choose a lesser one that is presented right away: *temporal myopia*. Only what is located within a certain horizon of presence proves relevant for the actions of the temporally myopic individual. Whatever stands farther away, beyond a certain temporal horizon, receives no consideration.

Experiments with adults to assess time-related decisions and temporal myopia are mainly conducted by using monetary values. After all, it is easy to reckon time in these terms: “Time is money.” Study participants are asked, for example, whether they would like to receive $1 immediately or, alternatively, to wait a week for $50. Needless to say, $50 is substantially more than $1; most people, in a wholly rational manner, will choose the greater sum, even though it is tied to a waiting period. However, when subjects are asked whether they would prefer to get $45 now or to be sent $50 in a week, they will, as a rule, opt for the lesser sum, which they can have right away. The difference between the two alternatives is too slight, and so the waiting period becomes unappealing. By systematically varying the quantity of money to be disbursed in relation to the $50 to be obtained after a week, it is possible to determine the sum after which a given individual will no longer choose the larger (but deferred) payment and instead go for the smaller one to be pocketed immediately. For instance, subjects may decide when offered $20 that “a bird in the hand is worth two in the bush.” Quantities less than $20 are too small for them to opt for immediate payment, and so they accept the waiting period to obtain more money; in contrast, any amount from $20 up prompts them to seek immediate payment. Even if the investigator has the participants’ trust—that is, even when subjects feel they can

count on receiving the money—a week of waiting presents an element of uncertainty. Under these conditions, the lower sum of $20, which is disbursed right away, is considered to be equal in value to $50. In other words, the waiting period makes the value of $50 sink to $20: depreciation occurs because of time—a phenomenon known as *temporal discounting*.

In this particular context, time and money represent convertible quantities. If the length of time before the payment of $50 is extended—say, from one week to two—test subjects prove even less willing to wait. In other words, even smaller sums are accepted by those who choose immediate payment; the $50 declines still more in value. Now, a subject might make do with $15. Conversely, when the waiting time is shortened, readiness to wait increases. If participants need to wait only two days for the $50, they might elect the immediately payable option only starting at the level of $35.

Researchers can now conduct a series of tests that vary the time before the larger sum will be received—say, between periods of one and thirty days. In each case, they identify the sum chosen for immediate payment as the equivalent of the larger sum to be received at a temporal delay. This value indicates the depreciation of greater gain on the basis of waiting time. Recording the equivalency index for each interval of waiting yields a function that can be expressed mathematically (see figure 1). As the waiting time grows, the equivalent amount becomes smaller and smaller. As the time required to wait before receiving payment increases, the sum that subjects are willing to accept right away decreases. On the basis of many studies, a typical hyperbolic function emerges between the increase of waiting time and the decrease in the equivalency rate.[4]

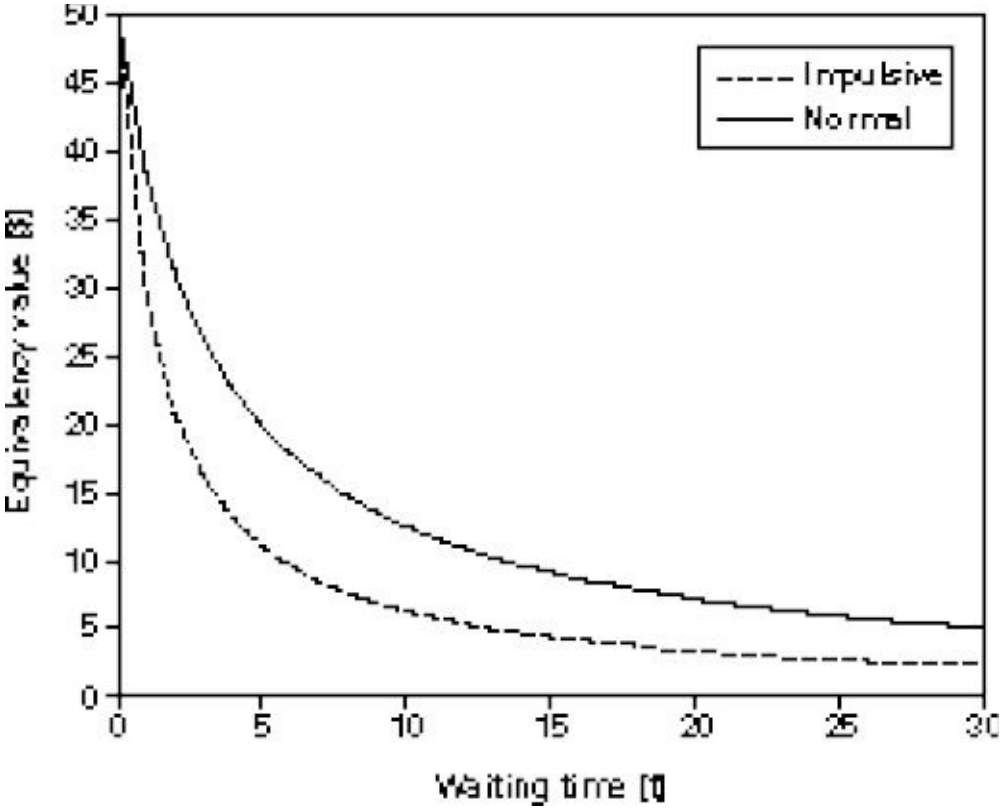


Figure 1
The curve shows the decrease of monetary value (equivalency value) when payment is deferred paym (waiting time). As the waiting period increases, subjective monetary value decreases. For impuls people, monetary value is lower under all conditions.

As can be seen from the graph, mounting waiting time correlates with a lessening equivalency rate. The reduction does not occur uniformly but hyperbolically; that is, if one compares brief waiting times (e.g., four and six days), equivalency decreases more than when the waiting time is longer (e.g., eighteen and twenty days); in the latter case, the difference does not prove to be as large. This is what temporal myopia looks like: stretches of time standing closer to us appear sharper than stretches of equal duration lying farther off. In this context, temporal myopia means, in essence, that we perceive the difference between today and tomorrow much more acutely than we perceive the difference between tomorrow and the day after.

This test, which economists use to investigate the rationality of behavior regarding monetary profits and losses, may also be applied in psychological research. Like the Marshmallow Test for children, it is sensitive to differences in the behavior of adults. More impulsive people will accept lesser sums of money,

whatever the waiting time involved, so they do not have to wait. With more impulsive subjects, the value of $50 decreases more sharply because of the waiting period. One may affirm that more impulsive people's experience of time —that is, the way they imagine it—is subjectively longer; that is why they opt for immediate payment, even when sums are lower. Such behavior exemplifies one definition of impulsivity: immediate, positive gain is valued more highly, despite the long-term consequences. This understanding of impulsivity also matches behavior displayed by children and adults with attention-deficit/hyperactivity disorder (ADHD). This group, like impulsive people in general, shows a greater tendency not to value deferred gratification; such individuals content themselves with lesser sums so they do not need to wait.[5] Thus, impulsive people display greater temporal myopia; they are more present oriented.

Natural Temporal Borders

To a certain extent, of course, all human beings display present-orientedness, or temporal myopia. When they lie in the remote future, events receive a different assessment than when they are imminent. Some people will exercise self-control and decline an invitation to a party that will happen in a month if they know that they have to pass a test on the following day. However, once the intervening time has passed and the party is happening tonight, they will often experience a change of mind: the party is too tempting. As soon as anticipated events surface within the subjective temporal horizon of the present, their value changes. Such horizons of the present vary in length, depending on the needs or urges at issue.[6] In the case of pressing hunger or thirst, a temporal horizon may involve minutes or hours; when it is a matter of attending a party, it may lie in the difference between today and tomorrow.

The perception of all that is situated in the temporal dimension of today is delimited by the natural rhythm of sleep and waking. "Today" is embedded between two phases of rest that constitute a natural border of time. Accordingly, all that might yet occur today is experienced as standing much closer. It is not just the number of remaining hours that make an appointment for tomorrow appear to be temporally remote. In physiological terms as well, tomorrow is a whole new day. Synchronized by light, the body's circadian rhythm governs the

cycle of sleeping and waking—along with many other processes—in a twenty-four-hour rhythm (see chapter 4). Accordingly, our physiological experience of each calendar day is new, for the fluctuations that occur in its course have entered a new phase.

There is also an annual rhythm that influences nature—and therefore human beings, too.[7] This rhythm depends on variations in light and temperature from month to month, which affect emotions and behavior. In industrialized countries, electric light and heating, which free us from dependence on outdoor conditions, have reduced seasonal fluctuations in rates of fertility and birth. All the same, "seasonal affective disorder," or "winter depression," remains linked to the beginning of autumn and winter, when the days get shorter and shorter. The seasons follow cycles that govern nature (e.g., the growth of foliage and fruit) and influence behavioral adaptations of animals (e.g., hibernation); accordingly, they have shaped human hunting patterns and agricultural practices. Still today, our social, political, and economic plans are packaged in yearly units—consider, for example, the government's school year, tax year, or budget year. The astronomic conditions that bring about the shift from day to night and the change of seasons structure biological processes on Earth in a cyclical fashion, but they also affect human experience and behavior—including the way that periods of time are perceived.[8] Farmers harvest what they have sown in the same year. We assess events situated beyond the compass of a day or year in a categorically different way than events that fall within this range. Payment that stands closer at hand (within the cycle) is more appealing than payment at a greater temporal remove (outside the cycle). As it is subjectively experienced, the temporal difference between something that will happen either today (this year) or tomorrow (next year) seems far greater than the same alternative when it will happen tomorrow (next year) or the day after (the following year). Even though, in both cases, the difference involves just one day (one year), our subjective preference for being rewarded "now" is greater. For biological and cultural reasons, human beings are accustomed to evaluating the stretches of time lying before them in terms of whether or not they fall within the period of a day or year.[9]

The Feeling of Time

While temporally removed events beyond a certain horizon tend to be assessed abstractly and hypothetically—that is, not so much in terms of emotion—those situated closer in time are evaluated more in the concrete and emotional dimensions that concern us here and now.[10] Whatever is experienced in temporal proximity elicits a greater range of physical and affective reactions, which influence decision making. For the purposes at hand, it is especially important to note that all the options at play in decisions, whether short or long term, are always assessed also in emotional (not merely temporal) terms. Only a computer following a program will calculate a state of affairs in a purely rational way, free of all emotion. Accordingly, it may be that no change in preference occurs: the wish to pass the test tomorrow and enjoy the rewards (or, alternately, the fear of failing) may provide a stronger emotional experience than the desire to attend the party tonight.

However, focus on the present should not be viewed as negative per se. The American psychologist Philip Zimbardo has elaborated the concept of *present-orientation* within a larger framework of *time perspectives*. Human beings display fundamental differences in how they manage the dimensions of past, present, and future. A questionnaire developed by Zimbardo and John Boyd enables researchers to ascertain how a given individual relates to the three time perspectives. By this means, studies have demonstrated the ways that a person's temporal orientation affects everyday behavior.[11] People who are unambiguously present-oriented, for example, stand out insofar as they live relatively dangerously: they tend to take more drugs, get more speeding tickets, have more unprotected sex, and so on. It sounds like the motto of rock stars in the sixties: "Live fast, love hard, die young." The attitude toward life expressed in these words is surely to be understood as a reaction to the future-orientation that otherwise prevailed at the time, as a perceived lack of spontaneity and lust for life. "Sensation-seeking"—pursuing distraction and new experiences—is related to both impulsiveness and present-orientedness, even if it is not quite the same thing as either. That said, orientation in the present proves essential for achieving a positive quality of life—a point to be discussed later. This perspective acquires a negative quality only when it becomes too pronounced and the individual in question loses the capacity to act freely inasmuch as she or he cannot break out of the present moment and plan for the future.

Recent studies, incidentally, have shown that some psychiatric and neurological patient-groups with heightened impulsivity demonstrate an altered

perception of temporal duration; this may account for temporal myopia and heightened present-orientedness. For example, children with ADHD experience greater difficulty judging intervals of time calculated in seconds; their estimates tend to be more imprecise and variable than those of other children.[12] For this reason, Katja Rubia, a neuropsychologist at King's College in London, has argued that impulsivity essentially amounts to a disturbance of temporal processing in perception and motor functions. On the whole, impulsive people perceive temporal duration, whether in seconds or minutes, as longer than those who do not display these clinical disturbances.[13] Such findings correspond to everyday complaints made by children and adolescents, who are more impulsive than adults for developmental reasons.[14] The question often asked by small children—"Are we there yet?"—can be explained by the fact that they have not learned what certain durations of time "feel like," that is, they do not yet understand the concept of time properly.

On the basis of the scheme devised by the Swiss developmental psychologist Jean Piaget (1896–1980), it was long assumed that children have to be seven or eight to possess a capacity for logical thinking that is sufficient for making correct judgments of time in a comprehensive fashion. However, more recent research has demonstrated that even infants can judge time accurately, although they are easily influenced by external conditions and circumstances. For instance, children think that tasks last longer when they involve heavy weights instead of toy bricks. Children are more sensitive to disturbance variables than adults. That children are more suggestible when assessing intervals of time derives from the fact that their ability to focus their attention has not developed completely.[15] Children often have difficulty concentrating on a task without interruption. However, after the age of eight, their capacity for judging time approaches that of adults, as does their ability to maintain attention.

In adolescents, on the other hand, "Are we there yet?" often follows from the sense that things are simply taking too long. Put in terms of the Marshmallow Test: as they perceive it, the waiting time is connected with costs that are too high; consequently, they discount greater returns if these rewards come later.

To be sure, the question of impulsivity and self-control is a primordial one. Conceived in Judeo-Christian terms, it even underlies Original Sin: Adam and Eve could not resist the temptation of eating forbidden fruit in order to attain knowledge. According to the Bible, a long-term punishment now affects all the

generations of humanity descended from them. Admonitions of parents and teachers—about the importance of putting off gratification—still echo in everyone's ears. In this context, scientists might be suspected of claiming that a successful life can be achieved only if people always delay satisfying their needs. But we should note that research has also shown that the regrets about exercising restraint prove much stronger—and can also last much longer—than regrets about yielding to temptation.[16] Someone who, as a student, missed the big party that everyone else went to and spoke about for days later, or someone who did not go to a proposed tryst, may lament "missing out" for years afterward. Regret over a wasted evening, on the other hand, usually does not last so long. Apart from the matter of one's subjective disposition, once a decision has been made, attaching excessive importance to success later on—that is, the overemphasis of the future perspective—can impair one's quality of life. Having an emotionally rewarding existence also depends on a hedonistic capacity to live for the moment, say, by spontaneously agreeing to spend an evening with friends.

People who meticulously pay attention to every entry in their calendars and are largely trapped by the future perspective—those who are always working toward a goal—forgo opportunities for experience. Time that is felt and lived, that is, a life rich in positive experiences, is made up of moments of fulfillment, often in the company of good friends or a beloved partner. Therefore, whether one lives out the moment or pursues gain over the long term is a matter of emotionally intelligent conduct and weighing decisions. Someone who is free and full of life does not always choose to delay gratification; rather, she or he is smart about when to seek enjoyment and when to wait.

Cultures of Time

In the present day, the balance between planning for the future and living in the present should not be understood in strictly dichotomous terms—as the difference between reason and emotion, Protestant virtue and Mediterranean vivaciousness, self-control and impulsivity, or, to continue the chain of association, the difference between the philosophies of Kant and Nietzsche or the little cartoon angel on one shoulder and the devil on the other. All the same, there is some truth to such a picture. Philip Zimbardo, a psychologist at Stanford

whose research focuses on time orientation, has talked about differences in his own family, Sicilian immigrants in New York. When he was a young man, they often seemed unable to understand why he spent his time reading and studying instead of joining everybody else and having fun. Zimbardo observes that misunderstanding arose in his own family because of different cultures of time:[17] he was more future oriented, whereas his family was more present oriented. Zimbardo has also extended his scientific findings to political matters. Many of the tensions that now exist between parts of Europe, he argues, can be traced back to divergent cultures of time. In particular, the conflicts between northern and southern Italy are based on diverging temporal perspectives inasmuch as northern Italians, who are more future oriented, clearly generate the greater portion of the country's wealth.[18] Within a given society, different milieus attach varying levels of significance to the future perspective. Those with lower levels of education tend to be more present oriented and less mindful of the future. The ability to delay gratification in order to achieve socially recognized goals is a precondition for membership in the middle class. In societies where structures do not reward long-term investment in the spheres of work and community involvement, people cannot develop a future perspective to give their actions meaning. Looking for the prospect of a brighter day, immigrants are often the ones who give the economy a push—precisely because of their future-orientation. Their relatives, who have stayed at home in present-oriented countries, on the other hand, consider other values more important. If individual chances for a better future are slight, then values such as keeping the family together and demonstrating solidarity predominate.



Figure 2
Professional fortune-tellers look for answers in the temporal perspectives of past, present, and future–this case, by reading palms or tarot cards.

A long tradition of separating momentary gratification from future-oriented reason exists in the history of science. The psychoanalytic terminology coined

by Sigmund Freud distinguishes between the superego (conscience) and the id (drives), both of which exercise pressure on the ego. The ego must strike a balance between these competing instances whenever a decision is to be made. Moreover, on this theoretical model, the id does not acknowledge time at all; it demands immediate satisfaction and therefore must be held in check by the superego and its conception of morality. In an allegory, Plato had pictured will and desire as two impetuous horses that must be bridled and guided by a driver —reason. Such notions have led modern behavioral scientists to postulate an impulsive system that is "hot" alongside a "cool" system of self-restraint, two agencies within a single individual contending for dominance; depending on which one gains the upper hand, immediate gratification or temporal delay occurs.[19]

But is this picture accurate? To be sure, we often experience conflict between the two positions—for and against comfort and convenience. The idea seems intuitively plausible. Indeed, some researchers even assign self-control and immediate pleasure to special regions of the brain.[20] Placed inside an fMRI scanner (a device for measuring brain activity indirectly), test subjects were asked in one study to decide between rewards to be granted right away and delayed ones. It was determined that when study participants chose the lesser, immediate reward, the parts of the brain known as the paralimbic system displayed heightened activity. These regions have a strong connection to emotional assessment. But when subjects deferred gratification, there was heightened activity in areas (e.g., the frontal cerebral cortex) linked to executive functions—in other words, capacities for planning, decision making, and controlling impulses.

Here, by the way, the story of the Marshmallow Test continues. Forty years after the initial investigation, fifty-nine of the participants, now in their mid-forties, were tested for a third time.[21] When he and his colleagues published the follow-up study in 2011, Walter Mischel himself was eighty-one. To test for how undesired reactions are suppressed, subjects were asked to react, as quickly as possible, to faces that appeared on a computer screen; when certain types were shown, a key was to be pressed. As a rule, people respond more to happy faces than to neutral ones. Instructed to press the key whenever a neutral face was shown—but not if a happy one appeared—test subjects had to suppress the inclination to react to happy expressions. The matter proved highly difficult insofar as the experiment called for faces to be shown in rapid succession;

participants had to react as quickly as possible. It was determined that individuals who had been unable to check their desire for the marshmallow in front of them as children were now more likely to push the key “without permission” when happy faces were shown. In people who had not excelled at deferring gratification as children, fMRI measurements revealed that areas in the frontal cortex displayed a somewhat lower level of activity.

But despite these findings, one may reasonably critique the emphasis placed on a dichotomous model pitting “self-control” against “impulsivity.” According to neurologist Antonio Damasio, all decisions also depend on emotional assessments in healthy human beings.[22] When a decision goes against an immediate reward, the value attached to the future is emphasized (in emotional terms). Ultimately, reasons that speak for exercise, health, and physical fitness—and against spending the evening watching TV on the couch—also receive an emotional assessment. Likewise, it is for emotional reasons—and counter to the tendency to seek comfort and convenience—that people will choose to work hard in order to achieve professional success later on; hereby, status and income act as motivating factors. According to Damasio, choices almost never involve a strict alternative between reason and affect. Emotional assessments play a strong role in all decisions.

That said, the anticipation of waiting can also reduce subjective rewards; as we have seen, monetary value decreases in relation to the increase of time reserved for waiting. The present—time as it is experienced emotionally—works as a lens by making everything that is happening now (or stands within reach) appear bright; in comparison, everything belonging to the future seems lusterless. In other words, temporal myopia sets in. However, it is the feelings—in unison with the sensation of time—that determine the value of the options for activity. The fear of an examination, even if it is still weeks away, may exercise a stronger influence on behavior than a temptation that is present here and now; as if by a telescoping effect, the weeks preceding a deadline are felt to be almost at hand: the event seems much closer to one who is worried about it than it does for others who are at ease. Time becomes highly pressured. Emotions and the experience of time change correspondingly; they are closely interlocked.

Political Myopia

Today, political discussions often include talk of shortsightedness. The debts piling up in some countries result from efforts to meet citizens' desires and needs for security and comfort; money is borrowed for the expenditure they require. But the debts must be paid in the future; the coming generation will have to bear the consequences of shortsighted behavior. It is much the same when natural resources and the environment are at issue. The arguments are always the same: material security now (assuring the country's economic performance and keeping jobs) must be weighed against preserving an ecological balance that is becoming more and more tenuous. Negative consequences are calculated for the future—for example, prognoses are made about what will happen in 2050 or 2100. The generation now living will not enjoy the positive consequences that may result from a more prudent way of managing natural resources. It is entirely possible for a child to learn to wait for a second marshmallow, provided that she or he really gets it. An adolescent can learn to appreciate the value of studying by getting good grades. But where debt-reduction or environmental policy is concerned, our experience of the consequences is not as clear. For learning to occur, feedback on the outcome of actions is very important, because meaning and value are based on activating a system of reward. Therefore, we need to expend greater effort and invest more imagination for our ideas about the future, which are abstract and hypothetical, to compete with the concrete, emotional demands of the present.

2 Looking for the Rhythm of the Brain

Does every human being possess a personal speed—is this what distinguishes quick people from slow ones? A decelerated cerebral rhythm would mean that the world passes by more rapidly from a subjective viewpoint. Indeed, some patients with brain injuries experience just such a time-lapse phenomenon. In contrast, an extremely fast cerebral clock would create the slow-motion effect that often occurs in moments of terror. For years, researchers have been trying to find the key to the mysterious rhythm of the brain.

Sten Nadolny's novel, *The Discovery of Slowness*, tells the story of John Franklin, the English explorer and captain of polar expeditions who lived in the first half of the nineteenth century. The biography, which contains many fictive elements, describes Franklin as a person who registers events and acts very slowly. As a child, he cannot play ball; the game is simply too fast. At school, he formulates his thoughts so laboriously that his teachers and peers often lose patience with him. Indeed, his own father calls him a dunce because he is so slow.

All the same, Franklin makes something of his life because of the persistence that defines him. As a young man, he first becomes an ordinary sailor. On one nautical expedition, he observes the beam of light circling a lighthouse. Unlike the other sailors, he does not see the beam as a wandering circle of light, but as an extended curve in space. It occurs to him that he must inhabit a broader present than his fellow human beings; for him, several moments are always bundled together, into one. Today, we might use language borrowed from camera technology and say that Franklin has a long "exposure time." His perception is slowed down so much that he experiences successive events as if they were simultaneous.

Franklin's teacher, Dr. Orme, invents a device to measure the speed of perception: on a disk fastened to a crank, which revolves around its transverse axis, a man is painted on one side and a woman on the other. When the disk is turned slowly, the man and the woman appear in succession. When it is turned rapidly, the couple appears simultaneously: the observer can no longer break

down the order in which the man and the woman come into view. By means of this device, Dr. Orme can measure different people's capacity for temporal perception. He turns the crank faster and faster; as soon as the viewer reports seeing the man and the woman at the same time, Dr. Orme notes the speed indicated by a counter. The faster the crank is turned, the higher the subject's capacity for temporal resolution—that is, the higher the speed of perception. Indeed, it so happens that Franklin reports seeing the two figures together when the device is turned at a relatively slow rate.

Even though Dr. Orme determines that John is slow, he believes in his intellectual abilities. Events will prove him right. Ultimately, his subject will become a famous explorer of the polar regions—and even, for a spell, the governor of Tasmania. On numerous occasions, Captain Franklin's slow but thorough thinking saves the lives of the men on his ship.

Thirty Milliseconds of Presence

Nadolny's novelistic biography is a work of fiction. All the same, the idea that human beings possess capacities for breaking up time that vary individually is an interesting topic of research. Cognitive psychologists use different versions of the measuring device described above. Tests involving the temporal order of two stimuli—two tones or two colored lights—determine the basic interval required for an individual to correctly identify their sequence. For example, two tones at different pitches are given in a random order. If the temporal distance between them is long enough, it proves easy for anyone to discern which occurred first. But then the interval is reduced step by step, until the subject can no longer indicate the sequence correctly. The procedure is repeated several times to ensure that the measurement is stable. Investigators ultimately arrive at a threshold at which the subject recognizes their temporal order in, say, 75 percent of the cases—that is, at a rate that is more than coincidental. In this manner, it is possible to determine the temporal order threshold for every human being—that is, a measure of an individual's ability of temporal resolution. The more precise a person's temporal perception is, the smaller the interval between the stimuli can be—and the lower the temporal order threshold.

Determining this temporal threshold of perception leads to similar results, irrespective of the senses and kinds of stimuli involved. For example, to test

hearing, two notes at different frequencies are used, as described above; alternatively, headphones are used: one click occurs on the left side and another on the right, and the subject has to say which one came first. To investigate temporal resolution visually, a computer screen displays two colored dots in succession. To measure the sense of touch, the subject's hands are stimulated in turn; the subject has to say whether the left or the right hand felt something first.

Comparing the temporal order thresholds for different senses reveals that in young people—typically students, the "customer base" for university research—the order of magnitude involves a few ten thousandths of a second (milliseconds, *ms*); more specifically, the range lies between 20 and 60 ms.[1] Older people, on the other hand, have elevated order thresholds; this is because cognitive performance diminishes somewhat with age.[2] Cognitive ability refers to working memory, that is, the ability to recall events correctly after a certain period of time. In addition, it means attentiveness, that is, the possibility to react to events quickly and decisively. At the same time, a connection also holds between intelligence measurements and the relative elevation of temporal order thresholds, which has been demonstrated in children and adults alike.[3] People with higher scores on intelligence tests tend to have lower order thresholds.

So was John Franklin's father instinctively right to call his son a fool because of his extraordinary slowness? Not really, for he was wrong about a fundamental matter. Of course, it is easy to understand his reasoning. In general, people who get things quickly count as intelligent. This much is made plain by conventional intelligence tests, which present tasks that must be solved within a certain time. People who are too slow get fewer points; the result is a low score.

That said, the correlation proves rather slight. Regarding the ability of temporal sequencing, only about 10 percent of the differences observed between people can be traced back to IQ. In other words, 90 percent of the differences derive from other factors. Relatively speaking, there are many highly intelligent people who demonstrate poor temporal resolution. Therefore, even if the connection determined proves interesting for scientific purposes, the order threshold test is not suited for assessing the intelligence of an individual. Moreover, undue value should not be attached to scores on intelligence tests. Only in part do they predict scholastic or professional success. After all, John Franklin becomes a respected captain and governor in Nadolny's novel. The capacity for solving truly complex and weighty problems in life cannot be

determined by a test so easily; many other factors, such as personality and social and emotional skills, play key roles (see chapter 1).[4] Naturally, when time is important, the gift of ready comprehension provides a great advantage. But precisely where complex problems are concerned, solutions often take time.

Another truly significant consequence follows from the study of how temporal succession is recognized. Credit goes to Ernst Pöppel, a brain researcher and psychologist. Inasmuch as threshold values for sensory organs are consistently determined to occupy an order of magnitude ranging from 20 to 60 ms, it is reasonable to suppose that there is a central brain mechanism that transfers information registered by the senses—seeing, hearing, and feeling—into a temporal sequence. Pöppel hypothesizes that the brain has a rhythm that guides perception and action.[5] Neural oscillations bring about a state in the brain that determines which incoming data count as temporal phenomena and which do not. All that is processed within the period defined by such a state—at a duration of approximately 30 ms—is experienced as simultaneous.

This rhythm, with period durations of approximately 30 ms, is not detectable in perception alone: it is evident both for temporal order thresholds and in data relating to motor response. If investigators have subjects perform several hundred reactions—say, by pressing a button on the left as quickly as possible when a note is heard, and one on the right when a light appears—it emerges that response times are not uniform. The distribution of response times includes several peaks; here, the temporal interval measures about 30 ms.[6] That is, human reactions do not happen at random intervals; instead, they occur only after a unit of time has passed, every 30 ms. That said, one should bear in mind that the brain is not a machine operating at a fixed rate with a precise length; it is a biological system. In other words, the cycle of neural oscillations (neurophysiological fluctuations in the brain) varies in duration, with an order of magnitude of a few tenths of a millisecond. Indeed, studies of brain activity accompanying conscious perception have determined period durations in the so-called gamma wave range, typically around 40 Hz.[7] This frequency range corresponds approximately to temporal-order thresholds of 20 to 60 ms. In conjunction with results from tests of perception and reaction, these neurophysiological findings can be interpreted to mean that our conscious experience—even though we take it to be continuous—occurs in small, discrete steps.[8] At the same time, an array of frequencies exists that can be measured by means of electroencephalography (EEG) or magnetoencephalography (MEG),

which are connected with processes of perception and cognition. Some researchers consider neural oscillations with frequencies around 40 Hz to represent the fundamental rhythm of the brain.[9] Very recent empirical research points to yet another potential rhythm in the brain with a frequency of 7 to 10 Hz related to the "perceptual moment." The notion of a perceptual moment lasting around 100 ms has a long history, but evidence is accumulating that perception for attended visual stimuli is modulated periodically over time with underlying neural oscillations of this duration.[10] More likely, however—and this speaks against an overly simplistic view—several different processing mechanisms operate in parallel on different time scales in the subsecond range to generate the perception of succession of world events over time.[11]

Dr. Orme also intended to devise an apparatus that would produce moving images by quickly presenting a series of illustrated pages, on each of which an element changes, bit by bit. The machine, a picture-drum, would flip very rapidly from one image to the next to generate the illusion of motion. This is the principle of film, which is designed in accordance with our faculties of perception. The lowest frame rate at which images are experienced as a continuum lies at about 20 Hz (hereby, a given image is shown for 50 ms before the next one appears). In the cinema, the frame rate is 24 Hz; conventionally, television screens operate at 50 Hz. This frequency corresponds to the human ability to break down time. Images must succeed each other at a rate that generates the illusion of a continuous process for the viewer.

The Central Clock

An important point of reference for brain researchers looking into the mental functions of human beings is afforded by clinical cases: patients with neurological and psychiatric conditions. When a certain psychic function ceases to be performed after injury to a certain part of the brain or illness, it follows that the area plays a decisive role for the function in question. For example, the acquisition of new memories is disturbed if the hippocampus, a part of the brain located in the temporal lobe of the cerebral cortex, is damaged. Both the storage of explicit knowledge—semantic memory—and the ability to recall experience—episodic memory—depend on the operations of the hippocampus. This part of the brain permits what has just been experienced consciously to be transferred

into long-term memory. Our ability to recall a conversation we had with a colleague yesterday is only possible because the hippocampus played an active role in storing away the content of the exchange and the situation in which it occurred.

In the 1950s, some patients who suffered from uncontrollable epileptic seizures underwent an operation that removed the temporal lobes at either side of the brain, where the seizures originated; in the process, the hippocampi (which form a pair) were taken out. This dreadful procedure is no longer performed today. The operation proved wholly successful insofar as seizures either no longer occurred at all or happened at a greatly reduced frequency. However, other consequences were drastic. When the hippocampus was removed entirely on both sides, patients proved unable to store conscious information at all.[12] At first glance, they communicated readily and did not seem impaired. But the effects quickly became clear. A newspaper they had read just five minutes ago was now filled with unknown information; the patients didn't even realize they had already read it. When a doctor or nurse seen dozens of times before entered the room, they seemed to be strangers. Patients could only recall their lives before the operation. They did not take in new impressions, but lived on an island of "presentness." Here, they knew only what they experienced in the moment (see chapter 3), along with short-term memory and memories from before the surgical procedure. The consistency of these cases proved shocking, but it vividly illustrated the function performed by the hippocampus: "entering" conscious experience into memory.

When complex psychic functions are at issue, usually more than one area of the brain is involved; for the most part—and this is also true for storing experience—a system of components distributed over the whole of the brain is at work. How, then—where the hypothetical rhythm of the brain is concerned—is it possible to locate an area, or for that matter, a neural system, that functions as a pacemaker for perception and motor operations? In other words, do we have a kind of internal clock that depends on certain structures of the brain and is responsible for recognizing temporal order? The answer is not clear. Initially, researchers managed to identify neurological patients who display a lesser capacity for temporal resolution. People who have suffered a stroke that has damaged parts of the upper left temporal lobe and lower parietal lobe commonly demonstrate language disturbance—aphasia—as well. Their ability to make out certain sounds of speech and understand the meaning of words and sentences is

impaired. Research has also shown that these patients tend to display higher temporal order thresholds—that is, they require larger intervals between acoustic or visual stimuli before they can correctly identify their order.[13] Patients who have suffered a stroke in other parts of the brain usually do not experience this difficulty. This fact indicates that the areas identified on the left side of the cerebral cortex play a key role in our ability to recognize temporal order.

These insights into the close connection between temporal sequence and linguistic understanding open a new perspective on possibilities for diagnosis and therapy. It is important to appreciate how the recognition of temporal order relates to the understanding of language. Hearers make out certain consonants in syllables such as */pa/ /ta/ /da/ /ka/ /ga/* by means of a process that distinguishes discrete phonetic events in succession. Vibrations in the air strike the ear at intervals lasting tens of milliseconds—they lie in the range of the hearer's temporal order threshold. Patients with aphasia display elevated temporal order thresholds; as a result, they have trouble recognizing the sequence of phonetic elements, which also means that they cannot distinguish well between consonants.[14] Children with speech development disorders display similar problems in recognizing temporal order and distinguishing between consonants —further proof that understanding spoken language is closely tied to identifying temporal succession.[15]

Diagnostic connections between phonetic recognition and temporal perception have given rise to different forms of training. Several studies with aphasic adults and children displaying developmental language difficulties have focused on systematically cultivating the ability to identify the temporal order of stimuli. Initial results are promising: after training, subjects demonstrate temporal order thresholds that are clearly lower, and the ability to make out consonants improves as well.[16] These results have prompted the development, mainly in the United States, of a device for diagnosing and training individual order thresholds. For all that, the procedures do not yet represent the norm in day-to-day clinical practice.

As previously mentioned, on average aphasic patients with brain damage need longer intervals of time between stimuli in order to recognize sequence. This fact might indicate the existence of an inner rhythm that has been decelerated. That said, on the whole patients do not report that the world around them is passing too quickly—as was the case for John Franklin. There are two plausible reasons

for this. For one, the rhythm of the brain might be slowed down as far as distinguishing phonetic elements is concerned. This involves operations in the range of tens of milliseconds; the inner rhythm might still be fast enough to experience events in the world as occurring with appropriate speed. On the other hand, it could be that there are problems for specific phenomena—above all, the perception of acoustic stimuli and, consequently, spoken language—but they do not extend to perception as a whole. In this context, it would be interesting, for example, to know whether patients with aphasia who display diminished temporal resolution are also impaired in their appreciation of music. Many components of musical experience—for example, the perception of pitch and melody—depend largely on the right hemisphere; in contrast, linguistic processing and the recognition of temporal sequence involve the left hemisphere. Nevertheless, this does not preclude the possibility that hearing music also involves the sequencing of activity in the left hemisphere. It may be that, beyond what laboratory measurements reveal, subtle temporal disturbances can also be demonstrated in everyday visual experience. At any rate, there are findings that point to patients' impaired ability to recognize the temporal sequence of visual impressions.[17]

The question of whether the brain has a rhythm that structures perception and motor operations has not yet been answered. If such a central clock existed and the brain's rhythm became imbalanced (say, after an injury), then all the senses —hearing, seeing, and feeling—would have to be impaired, in addition to the slowing down of behavior. Indeed, there are clinical cases of patients who display such disturbances after a brain tumor or brain inflammation. They are rare, however. Such patients report that everything around them is happening much too quickly. Like a film viewed in fast-forward, the world rushes past them at breakneck speed. These people avoid driving cars and even watching television, because the course of events proves much too fast for them.[18] The world goes by in a time lapse. One possible explanation of this phenomenon is that their inner rhythm has slowed down. If, after injury to certain regions, the brain operates more slowly, then events in one's surroundings would occur correspondingly faster. The lower the rhythm of perception, the faster events in the world appear to the viewer.

But there is no easy way to localize such a central cerebral rhythm, should it even exist. The first point to note is that some patients experience the time-lapse phenomenon only visually; when they close their eyes and have a conversation

or listen to music, their experience of time is entirely “normal.” Other patients report both visual and auditory acceleration. Such cases (which, on the whole, are infrequent) involve injuries on the right side of the occipital and parietal lobes.[19] The phenomenon of time lapse is also reported when damage to other parts of the brain has occurred; this indicates that a neural network is involved in how we experience the passing of time. Although isolated, these neurological cases can be seen to confirm the existence of a clock that is either central or dependent on several individual senses operating together.

The Slow-Motion Effect

There is also anecdotal evidence of the effects that come from a changed speed of perception. Situations of extreme danger—for example, accidents that nearly or really happened, or instances of violence—involve the opposite phenomenon: the subjective deceleration of experience. When, say, a truck is barreling head-on at one’s car, external events seem to unfold as if in slow motion. Afterward, the driver reports that she or he was able to perform all the required actions with uncanny calm—engage the clutch, shift, and accelerate—and thereby manage to avoid collision.[20] In such cases, the rhythm of perception speeds up. As the brain works more quickly in a situation of danger, the world outside seems to be moving more slowly. The function of such acceleration is clear: when the organism processes environmental stimuli faster than usual, it enables one to respond more readily and therefore, at least potentially, to react to threats in time.[21] This amounts to an advantage for survival. When heightened conditions of excitement prevail in the whole body, cerebral processes occur at an elevated rate, too. Accordingly, the movie *The Matrix* presents fight scenes in slow motion—a cinematic device for showing that the characters are acting in full awareness of the situations they face.

However, since it is ethically unjustifiable to create an experimental setting that is dangerous, it remains unclear whether people in such situations really experience slow motion, or whether—after the event, and on the basis of the emotional charge of what they have gone through—they simply believe that they felt everything happening more slowly. To investigate the matter, researchers in Texas under the direction of David Eagleman conducted an unusual series of experiments on volunteers.[22] First, a small device was used to determine

subjects' individual capacity for temporal resolution. Needless to say, the means used for measurement was very similar to that Dr. Orme invents in Nadolny's novel. The apparatus switched LED lights on and off so that a flashing number appeared. Foreground and background were composed of lights alternating rhythmically. In other words, foreground and background each appeared in turn. When the switch occurred slowly, subjects had no difficulty distinguishing flashes and identifying the number. Then, researchers increased the rate of the flashes. The frequency increased until foreground and background alternated with such speed that they ran together for the subjects' vision; only a uniform surface seemed to appear. In this way, they determined the individual threshold of each participant.[23]

The next part of the experiment took place at an amusement park. A tower rising thirty-one meters above a net offered thrill-seekers the chance to experience freefall. The operative assumption was that, during the terrifying experience of falling, perception would accelerate—in other words, the perception threshold for the flashing lights would be reduced. Before jumping, subjects were unable to see the number at a certain frequency of alternation; now, under conditions where the brain's rhythm was accelerated, they should be able to do so. The measuring device, which resembled a watch, was fastened to subjects' wrists, and they were instructed to look at it as they plummeted. Results were negative, however. Subjects still could not perceive the number. In subjective terms, the fall seemed to last a bit longer than what onlookers observed. On this basis, researchers concluded that the brain does not operate more quickly in dangerous situations—rather, in hindsight, the dangerous experience is thought to have lasted longer than it really did.

Many objections may be raised to the test conditions, of course. For one, it is always problematic when the controlled laboratory setting is abandoned for the world "outside." Various factors might have influenced results. For instance, could it be that subjects, as they were falling, were unable to look at the LED display properly? At any rate, the condition of measurement before jumping, when they had an undisturbed view of the LED lights, does not admit ready comparison with conditions during the fall. But despite the zero result, the study commands interest inasmuch as it represents the first effort to investigate, under real conditions, the phenomenon of perceived slow motion. Other unconventional experiments need to be conducted to determine whether the (hypothetical) cerebral clock can really be accelerated, and whether, under these

circumstances, a heightened capacity for temporal resolution is detectable.

Numerous laboratory tests have shown that threatening and emotionally charged stimuli are subject to overvaluation. For example, when experiments feature an image on a screen that seems to be moving toward observers, they assess the process as lasting longer than when the image appears to be moving away from them.[24] In the first case, the object on the screen is involuntarily registered as a potential danger, which leads to elevated bodily arousal. In analogy to the slow-motion effect that occurs in threatening situations, time appears to stretch out. A similar effect of temporal dilation can be achieved when emotionally fraught images are shown. Compared to "neutral" pictures, those that trigger highly arousing emotions—whether positive or negative—are thought to last longer. If investigators show erotic scenes or pictures of accidents, subjective duration is expanded as compared to when calm images—for example, grazing cows—are displayed.[25]

If an observer's ability to distinguish temporal sequence were to actually improve in situations that excite and activate the organism, it would provide direct proof of the slow-motion effect. Researchers have set the goal of using suitable methods of functional neuroimaging to determine areas in the brain that are responsible for the subjective experience of the passage of time. The challenge is to see whether a threatening situation can be approximately simulated in a laboratory setting. The search for the brain's rhythm continues.

3 In the Moment: Three Seconds of Presence

Feeling presence means being self-aware at every moment. We can increase our mindfulness of the present moment through simple exercises, which lead to a more intense feeling of presence. The underlying mechanism in the brain connects elements of perception to temporal units that last between two and three seconds. One can have such an experience through great works of art such as Beethoven's Fifth Symphony. Alternatively, one can simply relax and focus on one's breath.

Things were not always better in the "good old days." On the contrary, time brings with it many improvements. Consider the claims advanced by the Harvard psychologist Steven Pinker, who draws on statistics to demonstrate that violence between human beings—both in war and individual actions—has progressively decreased over the course of history.[1] Pinker argues that, in addition to the obvious technological advancement of civilization, a less conspicuous kind of improvement has occurred in terms of how we interact with each other. The probability of dying at another's hands has decreased on the whole over time. Also, human beings today display greater concern about the suffering of other human beings (and animals).[2]

Practice Makes Perfect—Even in Matters of Concentration

Another issue, which is significantly less dramatic, also has implications for our purposes: the subject of consciousness has entered the mainstream of research in the natural sciences; the pursuit no longer counts as avant-garde (chapter 6 will offer a theory of consciousness). Leading neuroscientists and psychologists researching the topic at top universities report, with a hint of irony, that one could not come "out of the closet" a mere twenty years ago. In those days, the rule was to hold off on researching consciousness until after tenure. The endeavor counted as esoteric and unsuitable for proper scientific study. Now, in contrast, we have a consciousness boom: every brain researcher who enjoys even

moderate renown has an opinion on the issue—or a theory of his or her own.

At first glance, it might not seem to matter much if natural scientists take up the subject of consciousness and work in earnest to understand it. But one should bear in mind the overall history of science and medicine. During the early phase of modern times, dogs were subjected to vivisection without anesthetization; the practice was justified by the belief that animals are soulless automatons. Today, consciousness is generally considered to represent a gradual phenomenon, or a matter of degree; it is acknowledged that many highly developed species of animals possess forms of consciousness and therefore the capacity to suffer. In the 1960s—only fifty years ago—the prevailing view of human beings in scientific psychology was still shaped, along the lines of behaviorism, by the stimulus-response approach. This conception did not grant consciousness a place.

Other positive developments have occurred. For example, cancer clinics oriented on Western medicine diagnose and treat people according to the most up-to-date knowledge in the field. Medical advances are still being charted, and the prospects of surviving cancer are improving. In large part, such success comes from quicker diagnosis, earlier on; at the same time, methods of treatment are becoming more and more precise. As a rule, patients at oncological clinics had been left to confront their fears alone even in the 1990s. Hardly any professional care was given to patients in this regard, and they often experienced an existential crisis. When the possibility of dying becomes the focus of awareness, it can be brutal; fear, depression, rage, and (deluded) hopes may result.[3] For such patients, everything changes. Plans for the future, which were made before diagnosis in anticipation of years and decades to come, suddenly shrink to days and weeks. Over the last decade, everyday clinical practice has begun to incorporate psycho-oncological and psychotherapeutic care. People no longer count simply as patients with bodies to be treated; their spiritual needs and desires are taken seriously.

In fact, it should be routine to focus on emotional matters in medical diagnosis and treatment. One need only consider the manifold problems that family doctors face day in and day out: situations of excessive burden at home and the workplace, which lead to “burnout” or chronic pain. It is also necessary to respond—cognitively, emotionally, and motivationally—to physical illness and the adjustments it requires. Serious bodily indisposition is often accompanied by fear, depression, states of disappointment, and feelings of disorientation. Some

people manage to deal with the new situation very well and receive emotional support from family and friends. However, this does not occur automatically. In consequence, clinics and rehabilitation facilities should employ methods of psychological therapy as a matter of course. In recent years, one particular way of dealing with difficult and taxing situations has been adopted at training centers and university research institutes: mindfulness meditation.

Mindfulness means concentrating on the present moment—that is, focusing and maintaining attention on experience as it is given, accepting and curious observation of one's thoughts and feelings without trying to evaluate them. As easy as it may seem at first glance, concentration on the moment is not easy to maintain. Concentrating on the moment, now, means feeling one's body as well as hearing, seeing, and smelling what is happening in the surrounding world. In the process, thoughts present themselves over and over; we are confronted by memories or, alternately, think about what we want to do next. The mind begins to wander. Impressions from the past as well as plans for the immediate future distract us from the present. As I am sitting here, now, in this room, on a chair, I feel my body; I am concentrating on the here and now, nothing else. If one has not practiced doing so, this condition proves difficult to maintain. Boredom soon arises, unrest seizes the body, or one experiences the wish to scratch or move. Thoughts come and go; one must steer attention back by an act of will time and again. Concentrating on the now becomes taxing. Over and over, it is a matter of freeing oneself from thoughts that surface, however banal they may be ("Do I still have enough milk in the refrigerator?") and getting back to oneself.

Jon Kabat-Zinn, a professor of medicine at the University of Massachusetts, has developed the method of "Mindfulness-Based Stress Reduction" on the basis of Buddhist meditation techniques.[4] By means of concentration exercises, patients learn to manage their symptoms by accepting them; in the process, they also learn how to alleviate them. Indeed, meta-analysis of many studies has confirmed that patients succeed in learning to deal with pain after mindfulness training.[5]

Mindfulness training involves, on the one hand, strengthening the ability to direct attention to the present moment, to experience both oneself and one's surroundings more consciously. On the other hand, one's acceptance of the situation is enhanced; what has been and what is now given is more fully acknowledged, and concern about the future diminishes. Heightened capacity for directing attention reinforces control over one's thoughts and affects. Likewise,

it is possible to learn to view, attentively and from a detached standpoint, the feelings and beliefs that can be overwhelming and take over entirely (e.g., anger at a colleague who has been annoying yet again). With the sources' underlying affects exposed, one no longer stands at the mercy of reactions that are disproportionate to their cause (as must often be admitted after the fact). A cyclist who has been cut off no longer needs to shout obscenities at the driver. Automatic responses may be overcome. Enhanced readiness to accept one's own feelings lessens anxiety and stress and produces a greater sense of inner calm. Focus falls on perceiving what is happening with full awareness. Neither what once was nor what might still occur represents an event that is concretely given in the present. All that counts at this precise moment is what is happening now: conscious experience.

The above may strike some readers as rather esoteric. Nevertheless, research on the subject is nothing if not sober and pragmatic. After all, medicine ultimately seeks to treat illness and alleviate symptoms in a verifiable manner (that is, on the basis of what admits empirical-scientific proof). Many studies in medical psychology demonstrate how mindfulness meditation makes it easier to accept pain, prevent stress, reduce the effects of aging on intellectual performance, and decrease withdrawal symptoms in smoking cessation—to list only four fields of application where positive effects have been charted. People trained in mindfulness display improved perception, thinking, and concentration; fear and depression decrease, and the brain exhibits verifiable changes.[6]

"Hey Jude," or The Three-Second Horizon

But what does it mean to concentrate on the moment? What do we mean when we speak of the "present moment," the "instant," or the "now"? Experience has presence. When we see, hear, and feel something, we do so at this very moment: right now. What was only just present belongs to the past in the next moment. In this way, a flow of felt time emerges: we anticipate an event, then we experience it, and shortly thereafter it lies in the past. We experience duration. Conversely, one can also say that we are constantly living in the moment—always exactly now. To be sure, events and our experience of them change in status: first they are expected in the future, then they are experienced fleetingly, and finally they remain only in our memory. All the same, our experiences are tied to the

moment. A familiar saying holds that we live from one moment to the next—that we move from one instant to the following one, as it were. However, it might be more appropriate to say that our conscious experience is determined by a constant being-present through which events pass: from futurity, which is not yet fixed, to what is experienced in the moment, and then onward, into the past. Planning for the future as anticipation and recollection as memory always occur *now*; this is a further reason to grant the time of presence a special status.[7] Around 400 AD, St. Augustine put the matter as follows: "Perhaps it would be exact to say: there are three times, a present of things past, a present of things present, a present of things to come."[8]

Analyzing our experience reveals the extent to which perception is tied to aspects of time: our recognition of temporal succession, rhythm, and movement. What we experience necessarily involves basic temporal qualities that display a certain duration; otherwise we could not grasp them at all. What I am aware of right now is a dynamic image of the world; all that occurs in the moment has a duration.[9] A melody contains a group of notes, composed according to musical rules. Spoken language can only be recognized as a series of words that are joined together. Individual notes and phonemes also have an allotted span; that is, the components of perception display a certain duration—if they did not, we wouldn't be able to register them.

Some contemporary philosophers affirm that presence not only has temporal extension, but also that, in keeping with the conception of consciousness advanced by the philosopher Edmund Husserl (1859–1938), the temporality of "now" includes elements of what has just passed as well as what is about to occur. The American philosopher Dan Lloyd offers the following example: anyone familiar with the Beatles will already expect "Jude" as soon as Paul McCartney's voice intones "Hey" in the song "Hey Jude." Even though the word has not yet been voiced, somehow it is already present. Likewise, when "Jude" is heard, the "Hey" remains present, even if vibrations in the air are no longer verifiable.[10] The line "Hey Jude" is perceived as a whole. Even if one concentrates on "Jude," the word remains inseparably connected to "Hey." The integration of sonic phenomena is not arbitrarily extended: the components "Hey" and "Jude" are more closely connected than the words "Hey Jude, don't make it bad." Moreover, this first line is certainly not copresent with the last lines of the song, which come minutes later. That is, the integration of elements has a natural temporal limit.

Analyses performed by Ernst Pöppel have determined that temporal units lasting approximately three seconds occur in music and poetry across cultures. This is the maximum duration of spoken units comprising a verse in a poem or a song.[11] One also finds numerous examples of Pöppel's three-second-thesis in complex musical motifs. Consider the well-known motif that occurs in the first movement of Beethoven's Fifth Symphony (G—G—G—E flat). Verses and motifs constitute natural units within works as a whole. In contrast, modern composers who employ drawn-out soundscapes—for example, Luigi Nono—generate particular aesthetic impressions because sounds extend beyond the three-second horizon.[12] According to Pöppel, the three-second rhythm that occurs in art expresses a fundamental cerebral mechanism that structures perception and action into discrete units of "now."[13] Needless to say, this does not mean that poets and composers have explicit knowledge that information is processed in durations lasting for three seconds. Rather, on the basis of implicit neurophysiological parameters, it has proven fitting for artists' aesthetic sensibility to divide lyrical texts and songs into temporal segments of this duration.

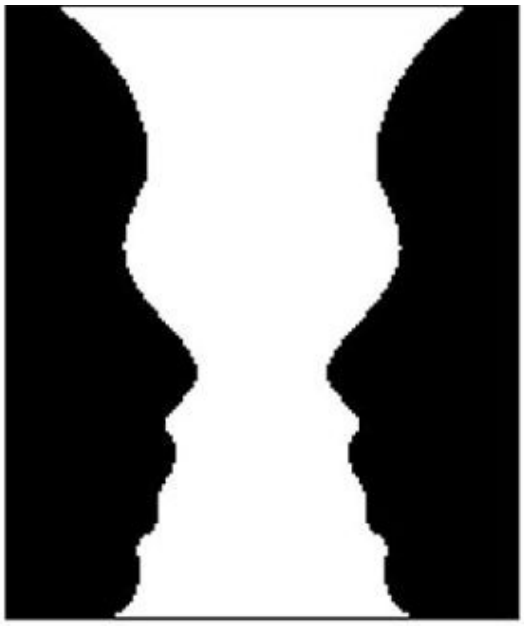
It might be objected that such strict temporal division does not mark our standard experience—that these examples, drawn from art, are special. This is true insofar as subtle methods of analysis are required to determine empirically that many instances of behavior and perception are structured in units of three seconds.[14] All the same, we can garner a great deal of evidence from everyday experience that points to a three-second meter for perception; indeed, one can observe as much in oneself.

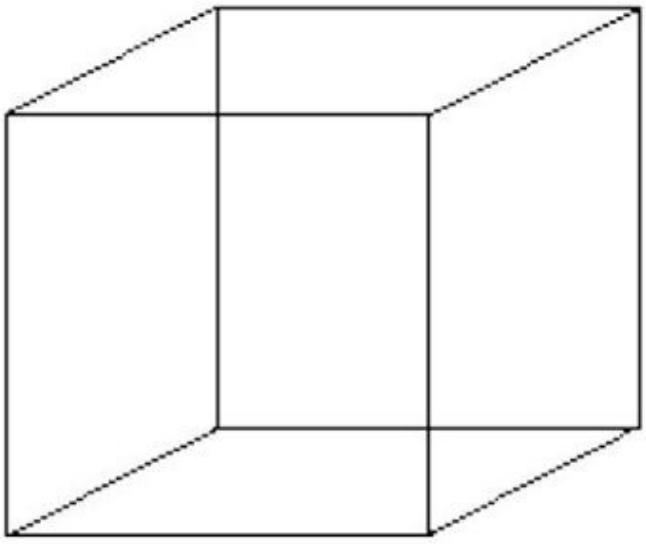
Most strikingly, perhaps, the metronome—the mechanical device musicians use to keep time by producing a regular series of beats—suggests the way time is integrated in our perception. Viewed in physical terms, the individual beats occur at fixed intervals, and a regular series of events occur for the hearer. However, the hearer automatically groups this sequence (tick—tick—tick—tick …) into auditory units (tick—tock, tick—tock …). Based on the frequency of beats, subjective units emerge: 1–2, 1–2, or 1–2–3, 1–2–3, and so on. From a physical viewpoint, these rhythmic shapes do not exist. By varying the rate at which beats occur, it is possible to determine the upper temporal limit at which a hearer can still hear the pattern of, say, 1–2, 1–2, 1–2. This limit is reached somewhere between two to three seconds. When temporal intervals occur just below this limit, one is still able to hear a grouping of beats. If the interval

between beats exceeds three seconds, one registers a series of individual events (1–1–1 …). In other words, the brain's capacity for temporal integration, which is what combines stimuli from the environment into units, has a maximum duration of three seconds. Likewise, a lower limit exists: if the beats are too fast, a series of events is perceived, but it does not yield accentuation or distinct groupings. When individual beats with an intermediary interval under 250 ms (a quarter-second) occur, one's capacity for grouping them—say, into patterns of four or five beats—collapses. It follows that the borders for integrating auditory events into perceptible patterns lie between a quarter of a second and somewhere from two to three seconds.

The same order of magnitude holds for the temporal segmentation of vision. One may confirm as much by employing a particular kind of visual object: reversible figures (see figure 3). These are drawings that admit opposing interpretations. A well-known example is the Necker cube, which can be viewed from two perspectives—the upper right or the lower left. Another is the Rubin vase, which can be interpreted either as a vase or as two faces looking at each other. The rabbit-duck illusion provides a further example of a reversible figure.

The philosopher Ludwig Wittgenstein used these figures to demonstrate, among other things, that we rely on perspective to understand the world: no single, universally valid description holds; rather, one must consider different viewpoints when describing the world. Varying accounts follow from varying perspectives. Psychologists investigating the processes underlying the reversal of perception have experimental subjects push a button whenever a change in perspective occurs in the course of looking at a figure. As it turns out, temporal segmentation takes place here, too: the switch between different aspects occurs approximately every three seconds.[15] First a duck, then a rabbit, then a duck, and so on.





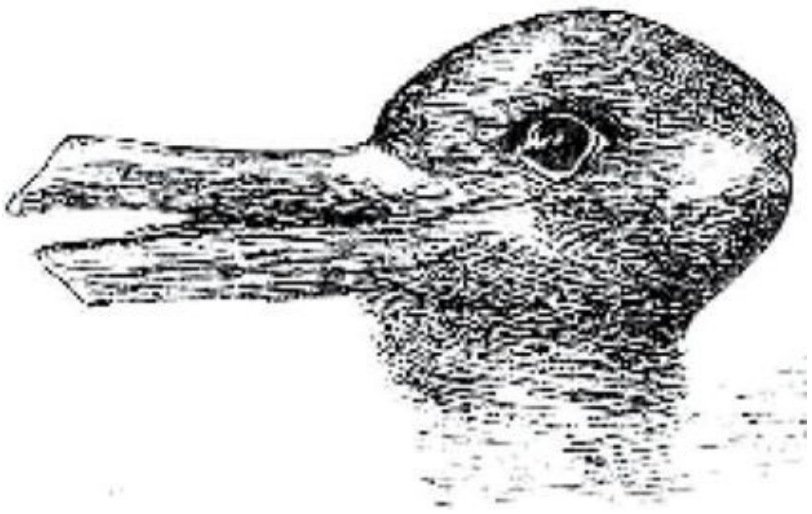


Figure 3
Examples of ambiguous figures that can be viewed in two different ways (from top to bottom): the Ru vase, the Necker cube, and the rabbit-duck illusion.

These and other findings point to a mechanism of temporal integration in perception and motor operations that lasts from two to three seconds. This mechanism combines individual events into mental temporal units. The "now," the moment, has duration. Many experiments have demonstrated that perception occurs in temporal segments. This has also been observed in behavior: units of three seconds occur in verbal and nonverbal communication such as spontaneous discourse, how long a handshake lasts, or, as noted, cultural works such as songs. Our experience of our surroundings does not involve temporally fragmented splinters of perception; instead, it consists of temporally coherent patterns of a certain duration. Our purposeful movements tend to have the same duration. Human communication takes place in a series of segments: the speaker bundles linguistic information into units, and the hearer registers them in the same way. Accordingly, verbal communication unfolds in a constant rhythm of three-second intervals. Because both partners in an exchange interact by means of these segments—that is, share a rhythm with each other—communication can be effortless. Moreover, analyses of interaction between mothers and babies have shown that phonetic units are regularly exchanged, each lasting approximately two seconds.[16] Communication is possible because of the common temporal structure through which human beings synchronize their interaction. One might also say that when communicating with each other, people share the time of the present: a shared temporal platform of presentness is operative in communication.[17]

Working Memory: More Than Three Seconds

The temporality of the present, which lasts up to a maximum of three seconds, represents the building block of our experience of time. When we say we are living from one moment to the next, we are referring to short intervals of life: now, now, now. In other words, we sense that our life and experience occur in a moving frame of "nowness" that has a particular duration. For all that, this moment, as the temporal building block of perception and action, does not last

long enough for us to understand ourselves as agents in a complex world. This feeling of presence—that we are beings acting in the world—cannot be reduced to a span of three seconds. This is where short-term or working memory comes into play, linking several of these moments identified on an elementary level into a greater whole. When writers try to depict stream of consciousness linguistically—say, a character's impressions, memories, and wishes—the matter cannot be treated fully in windows lasting only three seconds. The stream of consciousness is composed of elementary units of the feeling of *now*; however, the unity of our experience as actors in the world stretches beyond this limit.

We are endowed with linguistic capabilities and possess a narrative self. To experience and understand who we are, we have stories about ourselves at the ready: who we are, what we do, and what we want. But these stories take time. On a level higher than our experience of the moment, we constantly experience duration, which includes a point of origin and the potential for actions in the future. The feeling of an enduring self with a personal history and the capacity to influence the future defines us as persons.[18]

In terms of underlying cognitive processes, working memory forms the temporal bridge between individual moments of lived experience and gives rise to the feeling that one's own ego exists continuously in the world.[19] Beyond the integration of what has been experienced now, it involves processing experiences and thoughts that are somewhat removed, which range from what happened a few seconds ago up to a few minutes back at most. Thus, it is possible to take up again—and develop—a train of thought that was interrupted by a colleague who came into your office with a "quick" question. Notwithstanding an interruption of, say, thirty seconds, the thought does not disappear. The individual moment occurs now, and it lasts only a short time. All the same, we also experience a form of mental presence containing several moments that have recently occurred and lie within the span of short-term memory.

The patients suffering from anterograde amnesia we encountered in chapter 2 live on a temporal island of mental presence—a realm that extends for only a few minutes. Their short-term memory is not impaired, but they can no longer store in long-term memory the information that was collected in working memory. Normally, such patients do not attract notice in cognitive tests when tasks can be solved within the span of the mental present. However, because certain brain structures have been destroyed, they prove incapable of transferring conscious experiences into long-term memory. A doctor can explain the brutal

reality of the neurological disturbance, but the bad mood that seizes the patient as a result goes away after a few minutes: the condition that has been communicated has not been stored in memory. These patients function perfectly well within the temporal framework available to them, even if they cannot store new data in their long-term memory. Working memory constitutes a temporal horizon of mental presence within which the conscious experience of the narrative self is maintained over time, as a continuum. However, the narrative self is composed of stories we tell ourselves about ourselves; it draws from autobiographical long-term memory.[20]

The Best Moments of Life

To be sure, the common desire for a "more aware" life stems from the feeling of being unable to enjoy the moment.[21] A corollary of the thought that one is not living "in the now" is the feeling that one's experience lacks intensity. The feeling arises that life is passing us by and we are not "really" living: experiences come and go, yet they lack meaning. We often look forward to a special occasion, but afterward it seems to have occurred without genuine emotional involvement on our part. We did not take in the events as consciously as we had hoped. The intensity of lived experience proves lacking. Only too late do we lament: If only I had lived more fully when I was with someone dear to me (that is, more intensely, savoring the moment). Frequently, it takes a blow of fate to realize just how thoughtless and unaware one's life has been.

> What if I were not to die! What if life were given back to me—what infinity! And it would all be mine! Then I'd turn each minute into a whole age, I'd lose nothing, I'd reckon up every minute separately, I'd let nothing be wasted![22]

In *The Idiot*, Fyodor Dostoevsky puts these words in the mouth of a prisoner who thinks he has been condemned to death and believes he has only a few minutes left to live. This had actually happened to Dostoevsky himself: he was condemned to death and lived through the apparently final moments of his own life before being pardoned. He was thus writing from personal experience about the last moments of existence: they had passed with "extraordinary clarity" and were marked by attentiveness, even to insignificant details. His perception of time changed in a particular way, too: "He said those five minutes seemed like an endless time to him, an enormous wealth." Each moment is experienced

intensively and time expands—typical signs of an altered state of consciousness. Under different circumstances, one might actually wish for such an experience. States of consciousness like this most often occur in extreme situations of danger ("fight or flight"), but they also happen during moments of intense happiness. Under conditions of the greatest excitement, or when insight occurs in a flash, our attention achieves a maximal degree of keenness.

Situations of this kind are difficult to navigate. "Extreme" athletes such as climbers and parachutists seek out dangerous situations in order to experience such moments of intensity, when time expands. Bungee-jumping can trigger, for a few seconds, a similar physical state. Many people take drugs because they produce, without requiring any additional effort, heightened feelings and perceptions that otherwise do not occur at all—or only approximately—in isolated and highly infrequent situations of life. In contrast, ordinary, everyday existence unfolds between work and domestic activity; under these conditions, it is rather taxing to devote oneself to matters with full awareness. It requires concentration, and one has to maintain attention without being distracted by impulses arising from within or without. In *The Idiot*, the man who has been condemned to death only to be pardoned cannot keep his informal vow to savor every moment if only he be allowed to live. Despite his near-death experience—which involved utmost lucidity on his part—he did not go on to "live that way at all" but "wasted many, many minutes." Mindfulness is a capacity that must be learned. It is not unlike playing the piano or speaking a foreign language; every day, at least a little, one must practice.

All the same, the framework of everyday experience provides opportunities to perceive more fully, to live in the moment more intensely. The way that greater mindfulness affects the feeling of presence may be pictured, in part, by considering what it is like to come back home after an extended vacation. Familiar objects, which otherwise do not receive our full attention, acquire an almost magical presence. It seems they are new, even though we know they were always there. After a lengthy absence, the first day back is always special, and we experience daily routines and our surroundings with a particular intensity. The café on the corner or the rain-soaked streets of the city "back home" initially acquire a special significance—until the following day, when everything returns to normal. If only it were possible always to focus like that on life—how much richer and more colorful it would be!

The Wonder of Taking a Deep Breath

This is the place for the standard cultural critique: noise interfering with a mindful life in the present comes from the growing number of communications and entertainment media: information is not the only thing accessible everywhere and any time—we are, too. Sitting at the computer and simply working on a text, I have access to the World Wide Web and receive email at regular intervals; calls come in on the cell phone and the landline (predictably, the fax machine is silent). The latest news beckons over the Internet ("Who's winning?"); occasionally, the music playing in the background makes work seem effortless. Then a "must-see" television show comes on. Today, people in industrialized countries are accustomed to eating while watching TV; they also listen to music while jogging. A given activity (say, writing) is always being interrupted. Alternatively, we intentionally pursue several things at the same time—even if none of them receives our full attention. It is understandable, then, that experiences seem less intense: our attention must be divided (or, more precisely, it shifts back and forth quickly) between tasks. Moreover, activities prove increasingly subject to error because focused attention is wanting (it might not have been a good idea to write an email to one's boss or girlfriend during the show, but now it's too late). Also, talking on the phone seems hollow when we detect typing sounds at the other end of the line: my conversation partner is chatting on the Internet instead of just speaking with me. (See chapter 6 for a full account of the cultural criticism connected with observations of this kind.)

Where full attention is lacking, intensive experience is impossible. The Stanford literary theorist Hans Ulrich Gumbrecht expresses it as follows: what is missing is presence. Gumbrecht's account of watching four young people—two couples—sitting together at a restaurant, each of them busy with his or her cell phone, provides an almost comical example of the absence of presence.[23] The attention of these individuals has been thoroughly detached from their bodily presence. Presence is not simply a matter of mental focus; it also concerns the corporeality of the moment. The experience of presence occurs when body and mind, space and time, constitute a unity: here and now. According to Gumbrecht, our fascination with sports derives from the possibility—whether actively, as an athlete, or simply as a spectator—of participating in events that promote becoming "lost in focused intensity." The twenty-two soccer players on the field

are not the only ones following the ball in a state of utmost concentration; when they're in the world championship, hundreds of millions of human beings are simultaneously spellbound by a decisive penalty kick. Athletic training involves the maximal presence of temporally coordinated movements. Sports, which entail immediate proximity to one's own body, can give rise to moments of presence. What is more, the athletes who prove most successful are those who manage to let go of past failure and disregard the possibility of similar failures in the future in order to concentrate on the "now" of their movements. Sports psychologists train athletes' awareness of the present in particular.



Figure 4
Franz von Lenbach, *Shepherd Boy* (Schack-Galerie, Munich). At least for the moment, the shepherd b is fully and completely present. He is basking in the warm sun and air, and he feels the soft grou beneath him. All the same, he is alert—as shown by his hand blocking the sun. He can breathe calmly three-second intervals. Only occasionally does he lose touch with the here and now, when thoughts of beloved take him away from sensations of the moment.

Presence that is more comprehensive—incorporating the body, senses, thought, and emotions—may also arise when one is quiet. The Carthusian monk

Hugh of Balma (who probably died in 1305) offered advice on how to achieve a beatific vision by means of meditation:[24]

> V.46: Si quaeritur: Quid ergo cogitabo, cum de Deo cogitare non debeam, nec de angelis? dicendum quod solum aspirabit, non cogitabit.
>
> If someone asks: What, then, should I think if I am not allowed to think about God or the angels? He should be told just to breathe, not to think.

Simply by concentrating on our breathing, we can achieve states that are receptive to mystical experiences. Hugh sought to show that keenly refined intellectuality and knowledge—as afforded by theological study, for example—are not enough for the experience of God. Simply paying attention to breathing in and out, on the other hand, opens the way to experience of a higher order. Attentively sinking into the rhythm of breathing, quiet concentration on this physical process, is also a method used in mindfulness meditation. Breathing necessarily involves feeling the presence of the body, for its rhythm unfolds as one moment passes to the next. It is no accident that a period of a single relaxed breath lasts for about three seconds. The span of a breath lasts for the precise duration of a moment of lived experience.

4 Internal Clocks: What We “Need” Time For

The feeling of duration often serves as an “error signal”: it is taking too long for dinner to be ready or for the bus to come. Human beings have a relatively precise sense of time for a span reaching from seconds to a few minutes at most. To date, the only kind of internal clock that has been found is the circadian rhythm: bodily and mental processes fluctuate systematically over the course of the day. People represent different chronotypes on the basis of when daily highs and lows of performance occur.

When do we feel “time”? In what situations do we become aware of the passage of time? Hours can pass without us ever making an explicit judgment of time. A typical situation in which time enters our consciousness occurs when we wait, especially for a desired event. For example: school is in session, the weather is beautiful, the sun is shining, the fragrance of spring floats in through an open window, and students are sitting in math class. A look at the clock indicates that the lesson and school day will be over in fifteen minutes. Soon, everyone will get to go home and eat (hunger and anticipation of the meal); the afternoon beckons: freedom to play with friends. For a brief spell, thinking about the afternoon distracts the pupils, then their attention turns back to class; a girl is standing at the blackboard, trying to solve an equation. A nervous glance at the clock reveals that there are still fourteen minutes remaining until the lesson ends. Time expands: the single minute since the last look at the clock seems to have lasted forever. Time inches forward at a snail’s pace. The sense of passing time becomes physical: hunger grows, variables and numbers become more and more uninteresting; another look at the clock indicates that salvation still lies thirteen minutes away.

Another example: French tourists in the United States, and American tourists in France. Time-cultures (among other things) collide. At a fancy restaurant in Los Angeles, the French couple places their order and looks forward to a romantic evening. They have barely settled into intimate conversation when the waiter shows up with the first course. This is much too fast for the French sense of time. In Bordeaux, an American couple sits down for a meal at a restaurant.

They placed their order a long time ago, their conversation has now dried up, and they've eaten their baguette; as their hunger mounts, the feeling grows: "They've forgotten about us!" In fact, the food will arrive—but after a span of time quite different from what the Americans are used to. In either case, the guests at the restaurant become aware of time. In this way, the perception of time functions as an error signal indicating that something is amiss.

When waiting for an elevator or at a stoplight, two minutes can seem to take too long. Sometimes mere seconds prove irritating, for example, when the car ahead starts to back into a parking spot too slowly—why now of all times?—and keeps one from moving forward. When the feeling of time provides an error signal, it proves functional inasmuch as it calls for action. If, at lunchtime, too many people are using the elevator and it doesn't even stop at one's floor, it might be time to take the stairs. All the same, there are also situations when one feels trapped in time: there's no escaping a wait in a traffic jam, for instance. Unpleasant feelings may arise. Some people start to feel aggression creeping up, and combined with a certain amount of impulsiveness, this can lead to violent actions. As we saw in chapter 1, impulsive individuals overestimate the duration of events. When impulsivity, the feeling of being trapped, and a potential for aggression occur together, certain people may erupt in violence in order to get out of a situation that is felt to be inescapable.

This may seem like an exaggeration. However, the Associated Press reported just such a case in 2007.[1] Attacks by drivers on construction workers in California got so out of control that the highway had to be closed to traffic entirely. Work was being done to expand the roadway, and frequent traffic jams were the result. As construction proceeded, again and again drivers threatened workers, threw objects such as burritos, and even, in one case, fired a shotgun. The straw that broke the camel's back was when a man tried to run down a worker with his car. (He was subsequently arrested.) The spokeswoman for the state transportation department also interpreted incidents in terms of drivers' experience of time; she observed that people who are saddled with excessive waiting periods will often lose patience and overreact.

To be sure, this is an extreme case. All the same, it demonstrates how closely the perception of time is tied to strong emotions, which can lead to dramatic responses. Needless to say, one might also discuss the cultural dimension of such events. The Californians' reactions seem strange to Japanese. Indeed, intercultural comparison indicates that students in the United States attach less

value to rewards that are deferred until a later time (see chapter 1) than their peers in Japan.[2] In other words, Japanese are able, on average, to wait more patiently than people in the United States.

The evaluation of temporal duration and the speed at which aspects of life occur varies from region to region throughout the world. Robert Levine, an American social psychologist, has summarized his findings impressively in his book *A Geography of Time*.[3] The general picture emerges that industrialized nations view and manage time differently than countries that are less developed technologically; comparable variations occur between city and rural populations, big cities and smaller ones, as well as temperate regions in the northern hemisphere and more tropical lands. Dozens of studies conducted across the globe have verified these results empirically. Levine had his students—who came from all over the world—measure time in their home countries of, among other things, walking speeds and how long it takes to buy stamps at the post office. It turned out that the fastest cultures are found in large cities in industrialized, northern countries, where a great deal of attention is paid to time and punctuality and people live at a quicker pace, often feel rushed, and have difficulty dealing with delays. The other extreme involves cultures in rural parts of countries in the equatorial region, where people are in less of a hurry and work proceeds at a slower pace; here, one finds few public clocks—and even fewer that function—and people are more likely to pursue sociable forms of leisure, say, talking and drinking coffee or tea. Just as cultures may be distinguished in terms of political, economic, and historical factors, they can be defined in terms of how time is managed and subjectively experienced.[4]



Figure 5
A non-Western time culture: a gardener at Brihadeeswarar Temple in the Indian state of Tamil Nadu on the lawn and cuts the grass with garden shears.

Levine's analysis yields two fundamental cultures of time: the first works according to event-time, the second according to the abstract time of the clock. In the first case, people are oriented toward the duration of an event. A meeting can only take place when some prior activity (e.g., a conversation or a meal) has been completed. In contrast, people who are oriented toward the abstract time of the clock will interrupt what they are doing in order to keep an appointment. Industrialization succeeded because, among other reasons, humans can be made to follow time precisely. Clocks made it possible to synchronize sequences of work efficiently. Societies that are more oriented toward abstract clock-time prove more successful economically. Merchants no longer agree to meet at some point shortly after sunrise; instead, they meet at exactly 7:30. "Clocking in" ensures that employees arrive on time and work for a fixed period. People who come from different time-cultures run the risk of missing each other when they

make a date. Problems are practically preordained.

At first glance, it seems that bosses run chiefly on clock-time. When executives meet, the expectation is one of punctuality. In corporate environments, higher-ups demand that employees observe the schedule. Who can afford event-time is a question of power. An employee cannot afford to be ten minutes late for an appointment with the boss. The boss, on the other hand, can very well complete a telephone call or finish dictating memos to his secretary. Whoever holds power can make others wait.

How Can We Gauge Time?

The perception of time says something about the condition of the individual who judges that it is passing too slowly or too quickly. Time passes slowly when one is bored or yearns for the arrival of another; it passes quickly when one is "doing well." Ninety minutes on the plane, when traveling to meet one's beloved, can be excruciating; ninety minutes watching a good movie often fly by much too quickly. This is also the reason we see so many people staring at their cell phones on the commuter train: the Internet helps pass the time when traveling.

In such instances, time represents a vague feeling: either "This is taking too long," or "Too bad it's already over." A poem by Christian Morgenstern, which lends the mechanisms of time vivid expression, illustrates how our perception of time functions in everyday life, the way we experience the phenomenon:

"Time"
There's a way that's precise
To know the time in a trice:
Just take your watch to hand
And watch where the two hands land.
Then it will go, slow and meek,
Just as does an obedient sheep;
Step for step, graceful and cool,
Like a girl who went to finishing school.
But if you get lost in reverie,
Then it will dart forth speedily,
As if upon the swift ostrich's feet,

A stealthy puma, not missing a beat.

Then you take another glance;

But what's this, after the trance?

With an innocent smile, light and breezy,

Time treads slowly, soft and easy.

Although dressed up in playful form, the message is clear: when we pay attention to time, it passes (like an obedient sheep); when we are distracted from time, it runs away quickly (like a puma). In special situations, hours can sometimes fly by; they feel like minutes. Commonly, this involves the sensation of "flow," which has been extensively researched by Mihaly Csikszentmihalyi, an American psychologist;[5] often, it involves a sense of euphoria. The feeling of flow occurs when a person, in a state of utmost concentration and complete motivation, pursues an activity and reaches the limits of his or her capacity, without the challenge proving too great or too small. It might involve the conception and elaboration of a new idea, writing an important document, or performing music in a group. A high degree of skill, focus, and dedication must work in concert so that the actions required to perform the demanding task are completed as smoothly as possible. Such concentrated activity requires that time be disregarded; time flies by, as if it did not exist at all. Once work or play that has happened in a flow is over, one is surprised to find that it is already dark (or light) outside.

But how, precisely—in contrast to physical time or, alternatively, time as measured by the clock—do people assess temporal duration? Can animals also do so? We know that rats, mice, pigeons, and certainly monkeys can gauge time. Many animals have been shown to be able to assess short spans of time relatively precisely. For example, test animals are trained to press a disk or lever after fifteen seconds. If the animals do so after this interval (allowing for a small margin of error), they are rewarded with a piece of food. That said, the animals sometimes need dozens—or even hundreds—of trials before they consistently (i.e., with a certain degree of probability) exhibit the desired behavior.[6] Animals cannot be given verbal instructions; they must learn what to do by trial and error, which can last quite a while. However, once they have learned, pigeons will use their beaks, and rats their snouts, to push the disk or lever after the interval has elapsed. In one particular task of time-assessment, monkeys learned to hold down a key down for periods varying between two, four, and eight seconds—depending on the color of a light signal; for example, they displayed the ability

to press the key for eight seconds when the light was red, four when it was green, and two when it was yellow.[7]

When studies are conducted with human beings—for the most part, psychology students—some tasks for measuring the perception of time are common: acoustic or optical stimuli of a certain length are provided to determine the ability to assess temporal duration. In one experimental paradigm, once the stimulus has been given, subjects are asked to press a key for exactly the same span of time, that is, to reproduce the duration. In another experimental paradigm, when assessing the ability to discriminate duration, two stimuli of different length—tones, for instance—are provided; subjects must indicate which of the two was longer. The standard might be a tone that lasts exactly one second (1,000 ms). Then, the duration of the second tone is varied (1,050 ms, 1,100 ms, 1,150 ms, 1,200 ms, etc.; the sequence of the standard and comparison tones is also varied), and responses are collected. On the basis of these responses, it is possible to determine how large the difference between the two temporal durations must be for subjects to reliably determine which of them is longer. In other words, a threshold of duration discrimination is established. These two methods offer the advantage of not requiring verbal judgments of absolute temporal duration (e.g., “The tone lasted four seconds”); instead, researchers can determine subjects’ capacity for temporal perception down to the millisecond, either by means of analyzing the duration of the key press in the duration reproduction paradigm or by way of analyzing the accuracy in the decisions concerning the length of the two tones in the duration discrimination paradigm.[8] Verbal judgments rely on spans broken down into seconds; moreover, subjects make crude estimates by rounding numbers up or down: “about ten seconds.”

Especially when the temporal durations last for several seconds, many subjects involuntarily experience the need to count. They want to apply a “time ruler,” as it were; in consequence, they can offer very accurate estimates. Preventing this is not easy. Some researchers trust their subjects and simply tell them not to count. Another possibility is to provide a second task to be performed at the same time; the distraction is meant to keep subjects from counting. But then the danger is that the second activity will interfere with the primary task of estimating time. Experiments demonstrated conclusively that subjects considered spans of time that were prescribed (i.e., experienced) to be longer than periods in which they were asked to perform a second task. Such

results match what is described in Morgenstern's poem: if one is distracted, time seems shorter.

Does a Physiological Clock Exist?

Despite one hundred and fifty years of experimental research on the experience of time, there is still no consensus about how the nature of our capacity for perceiving and discriminating temporal duration. Michel Treisman, of Oxford University, first proposed a working model for a kind of internal clock in 1963:[9] a pacemaker in the brain emitting pulses at regular intervals, which are collected in a counter; in turn, the number of pulses collected in the counter is supposed to define subjective duration. By means of this cognitive model, one can readily explain why a span of time that lasts longer in physical terms is also perceived as being longer in subjective terms: the hypothetical counter has collected more pulses.

Subsequent revisions of the simple model of pacemaker and counter introduced attention as a component:[10] only when one is attending to time are impulses registered by the counter. If one is distracted, fewer pulses are counted and time seems to be shorter. This version of the model also explains why time seems to last longer when we are waiting. If one is not distracted and pays attention to time while waiting at the doctor's office, twenty minutes can feel like a very long time. In contrast, if one happens to be reading an engaging novel and does not heed the time, the same twenty minutes pass rapidly. The pacemaker model fits well with the experience of time portrayed in Morgenstern's poem. In the first case, a large quantity of pulses went into the counter; in the second, only a few.

The fact that researchers have proposed a vast array of alternative models indicates that this model hardly offers the final word.[11] For instance, temporal features of memory—specifically, the disintegration of memory traces—might function as internal signals for the passing of time.[12] Accordingly, the sense of temporal duration would be linked to how keenly one recalls events at the beginning of the temporal interval in question. The more time that passes, the weaker the recollection of what occurred at the outset will be. On this model, there is no separate mechanism responsible for assessing time—no "watch" in

the brain; instead, the sense of duration arises as memory traces of events in the past subside.

Another view holds that the sense of duration comes about through the feeling of intellectual and emotional exertion.[13] Novel events are felt to last longer because they make greater claims on the faculties of perception, thinking, and emotional assessment. In contrast, familiar items do not require special analysis or evaluation; perceiving them is not as intensive. Accordingly, the effort expended also contributes to the evaluation of temporal duration. This model also does without a special, internal clock that is “read” when time is gauged. Rather, we are constantly engaged in mental activity and judge situations as they arise. The sense of time emerges from the degree to which attention, memory, thinking, and feeling are activated.

In sum: at least so far, brain researchers and psychologists have not discovered an internal clock responsible for spans of time ranging from seconds to minutes. The pacemaker-counter model is just a metaphor, anyway—a ticking stopwatch that can be turned on and off. All efforts to find a physiological mechanism in the brain representing the sole instance for the experience of time have proven unsuccessful until now. Or, to put matters more precisely: there is no universally accepted theory of temporal perception (chapter 7 offers a new model combining information from the fields of philosophy, psychology, and brain research). Still, despite criticism of the idea of an internal clock as oversimplified and mechanistic, the pacemaker-counter model has proven adequate to describe many phenomena. According to this model, the subjective perception of time can be influenced by means of two mechanisms. The first involves directing attention, as discussed above, which has an effect on the pulses being counted. The second mechanism operates by way of the frequency at which pulses are emitted. If the rate of the pacemaker is increased, the pulses accumulate at a faster rate. This entails a subjective lengthening of duration.

In the early 1930s, the wife of American physiologist Hudson Hoagland was bedridden with a fever. Whenever Hoagland left the house even briefly—say, to go to the pharmacy—his wife complained about the length of his absence, which had lasted far too long in her mind. Every bit the scientist, Hoagland promptly performed a simple experiment on his spouse, instructing her to count to sixty. As it happened, she did so rather quickly—once, after just thirty-seven seconds. Hoagland concluded, on this basis, that the fever had produced a level of physiological activity higher than average, and that this had made her count

faster and, by the same token, overestimate temporal duration significantly. This overestimation of time can be described with the pacemaker-counter model. The heightened level of physical agitation leads the pacemaker to operate at an elevated frequency; accordingly, more pulses are accumulated. Thus, the wife came to think that, say, ten minutes had passed, even though her husband had only been gone for five. In an article published in 1933, Hoagland already speculated about an internal clock running at different rates depending on physical conditions.[14]

The Sliding Window of Time in Human Consciousness

We have still not asked one important question: What time frames should models focus on in the first place? When we say that someone has pressed the doorbell for too long, it is a matter of, say, four seconds. If a stoplight refuses to change, we evaluate temporal durations in terms of minutes. We make our assessments by voicing a feeling ("The light's been red too long"). Only when a comparison is drawn to time on a clock do we use physically determinate units—seconds or minutes.

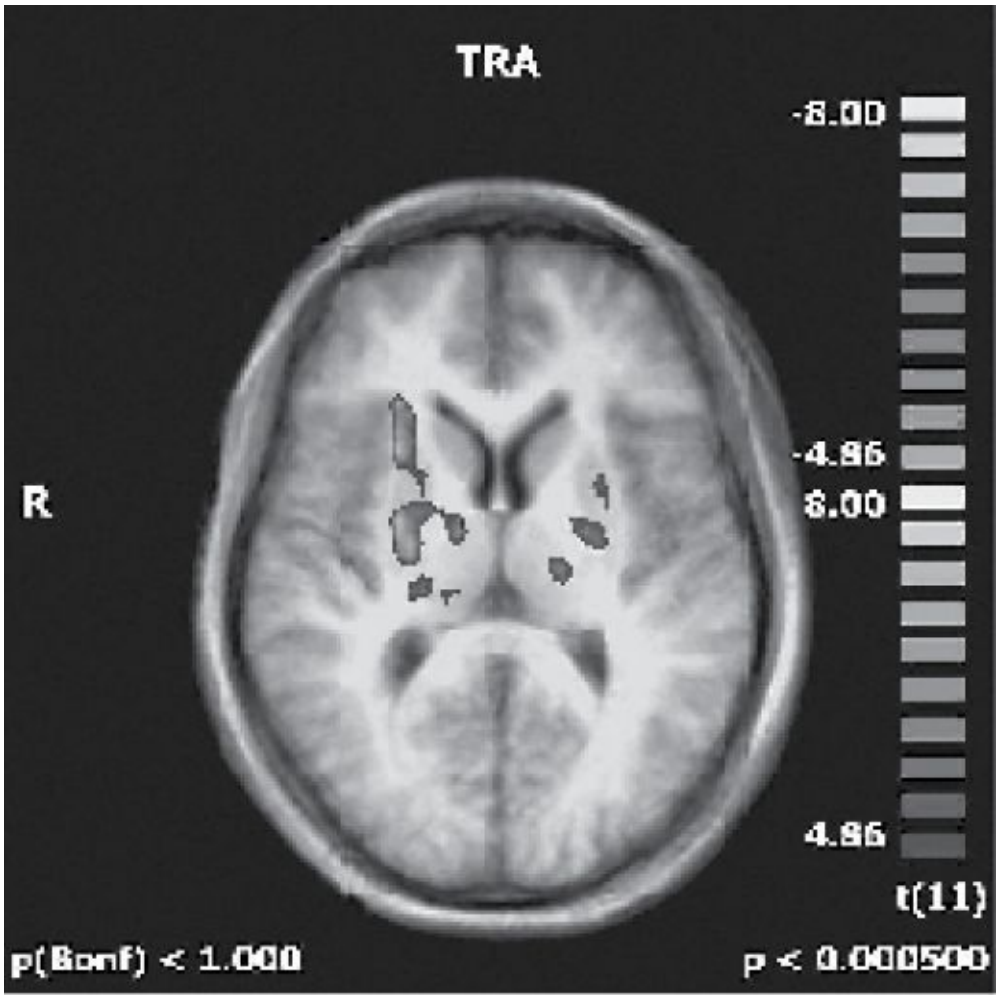
In La Jolla, near San Diego, there was an intersection that was notorious among my colleagues for the wait it imposed on drivers. Because the research group working under Martin Paulus had offices off campus, it was necessary to cross a large thoroughfare on foot or by car to reach various university facilities. The stoplight annoyed my colleagues and me because it took "so long" to switch to green. One day, I measured how long it stayed red; two days later, I double-checked the measurement. The light stayed red for two minutes and fifteen seconds. When I asked them how long the wait lasted—which they had experienced again and again over the years (and often several times a day)—most of my colleagues guessed too high. It should also be taken into account that one frequently arrives at a light when it is already red, and the switch to green occurs in less time. This slight vexation reveals two things. In a temporal extension that is only two minutes long, people already lose patience. "Two minutes" is a unit of time commonly used to indicate that one will do something "right away." In this case, two minutes proved too long in subjective terms. In addition, this annoyance shows how imprecise assessments of time can be, even in the range of only two minutes. The question, then, is how much time human

beings can estimate with relative exactness. The answer would demonstrate that a temporal mechanism—whatever its precise form—is at work.

The first item to note is that durations lasting up to about three seconds can be estimated rather precisely and accurately. If tests are conducted on the same person, the variance of subjective estimates of duration proves relatively small when intervals last up to three seconds. Only when durations are longer than three seconds do larger deviations between objective and subjective time emerge; estimations become less accurate.[15] There is nothing magical about three seconds; this value simply means that perception and activity occur at an optimal level within this period of presence, the "now" (see chapter 3). Within these limits, we can assess temporal duration precisely, and perform our actions similarly. After all, timing was important for survival when responding to one's surroundings—when fishing or hunting, for example, or when defending oneself against predators or other human beings. In today's world, the issue is more likely to involve timely response to traffic. Music and sports are other spheres where temporally exact sequences are necessary. Here, fractions of a second can determine the success or failure of an operation. Even when we do not pay attention to time, the brain is constantly processing information about the duration of environmental stimuli, especially when recurrent events are at issue. If this fails to occur with a certain level of precision, a dancer may well step on his partner's toes. When scientists researching temporal perception investigate the capacity to discriminate between two short tones, they tap into a finely honed system of perception and motoric operations that is focused on processing temporal duration experienced in the "now." The same is made clear by research on how people perceive time conducted by means of imaging technology such as functional magnetic resonance tomography (fMRT), which makes brain activity visible: when subjects lying in the fMRT scanner are asked to distinguish between different temporal intervals, areas of the brain that are involved in motoric planning and execution display heightened activity (see figure 6).

The French psychologist and time researcher Paul Fraisse (1911–1996) distinguished between perception and the estimation of time.[16] When time is *perceived*, temporal durations up to about three seconds are processed as a related whole. If the duration of a stimulus exceeds three seconds, the event becomes too long to be perceived as a temporal whole; then, duration must be assessed with the aid of short-term memory. The duration is no longer experienced as a total event of "now." A few seconds ago, a note was struck, but

it can still be heard. The beginning, which happened three or four seconds before now, is no longer present, yet the memory function still retains it. Such circumstances make it clear why the accuracy of temporal evaluation decreases at intervals lasting more than three seconds: because the interval is no longer temporally present as a whole, the operations of short-term memory are required to assess duration.



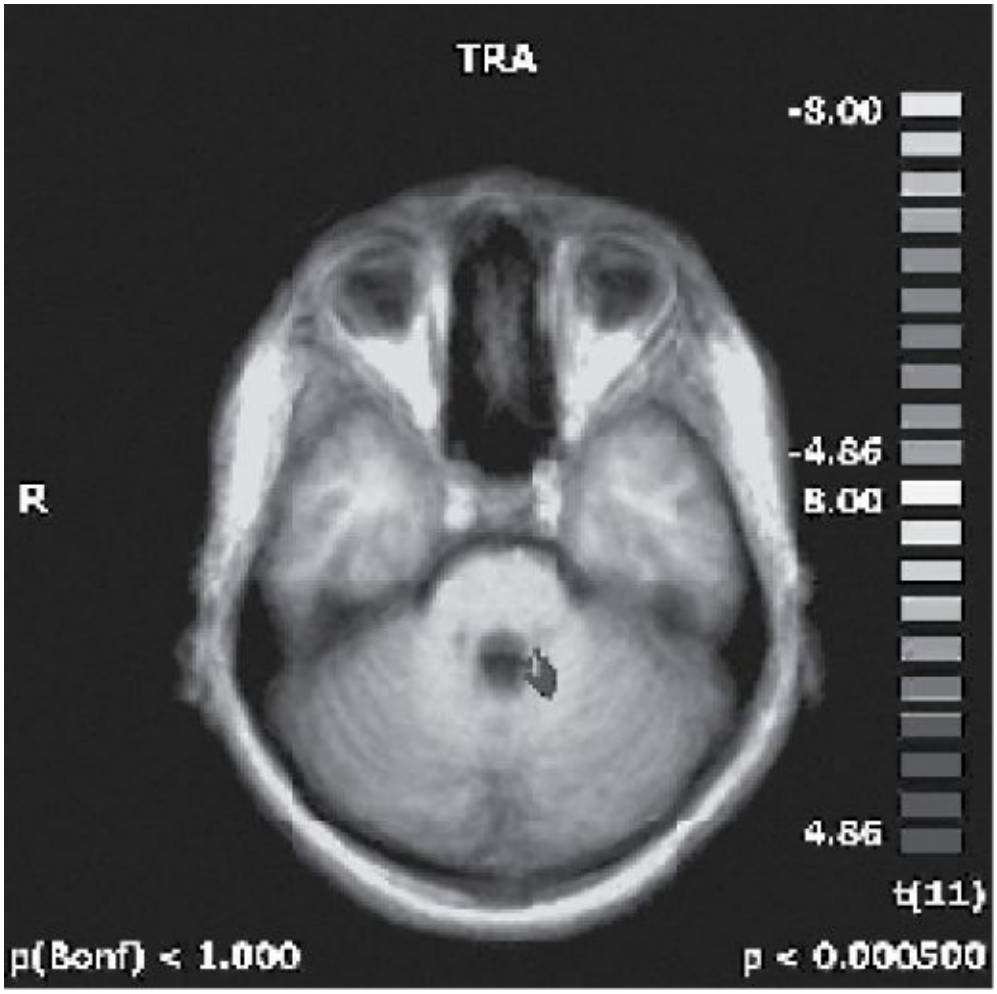


Figure 6
Brain activity of a subject performing a task to determine duration discrimination with one-sec stimuli, compared to the state of rest. The basal ganglia (left) and cerebellum (right) are especially act —regions that play a pronounced role in controlling sequences of action.

Even if our estimations of durations longer than three seconds prove increasingly inaccurate and variable, we still have a sense of this longer duration. What is the maximum interval that we can experience with full awareness—that is, focus on attentively—as continuous and uninterrupted? Researchers can instruct subjects to press a key every hour, in other words, to produce a series of one-hour intervals. The intervals that are produced in this way differ markedly from physical time, but the order of magnitude still proves correct. Despite this, when the period lasts an hour, we can no longer say that people are having a *continuous* experience. Many things can happen over the course of an hour; attention is constantly drifting. One needs to remind oneself over and over that one is supposed to estimate how long it takes for the hour to pass. Ultimately, it

proves a matter of making estimates on the basis of all that has been experienced—guessing the duration of activities that occurred during the time that has lapsed ("It took about twenty minutes to wash the dishes"). Memory constructs the duration of the hour that has gone by. Or, put somewhat differently: the mechanism for assessing time does not "tick" for an hour (or operate in any comparable fashion). There must be a natural limit up to which we can perceive temporal duration as a continuous and coherent occurrence. Simply cooking a three-minute egg probably already takes us to the outer limit of temporal perception, if not beyond. On a Sunday morning, we can test our abilities by means of the consistency of a three-minute egg, which reveals the imprecision of our estimates. It proves extremely difficult to focus attention on the pot for three minutes. Associative thoughts arise, which keep us from concentrating on the time. Indeed, there is great danger that something important will come up, causing us to get back to the egg too late. All the same, this little exercise in concentration may succeed—provided that one overcomes boredom. Someone who is practiced in meditation will have an easier time managing the task. People who meditate regularly are used to maintaining attention over a longer span of time—to being mentally present (see chapter 3).

The length of our short-term memory sets a natural limit for our continuous experience of temporal duration. When one tries to remember a telephone number, it is quickly forgotten (within a few seconds) if one does not repeat it to oneself. Working memory is involved when different things must be processed during the span of short-term memory—for example, when one is reading a text aloud but must also retain a series of numbers. Systematic experiments have demonstrated that subjects are no longer able to remember the greater part of new numbers or letters after just twelve seconds, if they are kept from actively repeating them. Working memory continues to function over longer spans of time, but it seems that the greatest loss of conscious content—at any rate, abstract content—occurs within ten to twelve seconds. A fixed upper limit cannot be drawn; it depends on what is supposed to be retained, as well as context. Still, a minute seems to be a generous estimate—half a minute might be more realistic.[17]

As far as the contents of consciousness are concerned, and in the context of working memory, we can speak of a "sliding window": we are always experiencing new things as time passes; simultaneously, however, we forget what has just happened. Experience relies on this temporal window of

consciousness, our mental presence. The boundary conditions of working memory also set an upper limit on how long we can experience temporal duration continuously, without interruption. Accordingly, the mechanism of perception related to the continuous experience of spans of time—which still has not been discovered—is restricted to a range of seconds up to just a few minutes.

The Real Internal Clock: Circadian Rhythm

As we have seen, researchers have not yet found an internal clock underlying our perception of time in the range of seconds to minutes. All the same, there is an internal clock; it exists in organisms from single-cell organisms up to human beings, and it steers physiology and behavior in cycles of twenty-four hours. This mechanism corresponds to the change between light and dark that occurs on the Earth over a single day: in this temporal rhythm, algae move between different depths of the ocean (alternately absorbing nutrients at lower levels and undergoing photosynthesis above, closer to the light), plants open and close their blossoms, and mammals rest and wake. Circadian rhythm (Latin: *circa* = about, *dies* = a day) is evident in many biological functions, including gene expression. In human beings, periodicity can also be demonstrated in moods, thoughts, and the perception of time. For example, the expression of feelings, the capacity for mental calculation, and reaction time are subject to systematic fluctuations over the course of a day.[18] Many cognitive operations—that is, the speed and exactness of thinking—improve before noon; at midday, they prove optimal. Incidentally, this is a reason not to schedule core subjects at school or important deadlines between eight and ten o’clock in the morning. In turn, the capacity for performance decreases over the course of the early afternoon.

Circadian rhythms are endogenous: one or several pacemakers in the organism regulate periodicity over the course of a day. This occurs even without the influence of the sun. Plants that extend their leaves to the sun in a daily cycle also do so when one puts them in a dark room. The endogenous nature of the internal clock has also been demonstrated in human subjects. During the 1960s, in the legendary “bunker” experiments conducted by Jürgen Aschoff at the Max Planck Institute for Behavioral Physiology in Erling-Andechs, volunteers were locked up for three to four weeks (they included students who wanted to study for exams).[19] Even without any form of social contact that might indicate daily

routine (needless to say, wristwatches had been removed), and without the natural change from day to night (there was only electric light, which subjects could turn off or on at will), patterns continued as before: sleeping, waking, fluctuations of body temperature and other bodily functions. However, one difference from the cycle of twenty-four hours in a natural setting was noted. Endogenous rhythms had longer period durations—about twenty-five hours, on average. That is, under conditions of isolation, the subjective day—getting up, going to bed, and all other bodily parameters—took a little longer. Moreover, the phase differences between individual parameters entailed a consequence: whereas different rhythms normally occur in conjunction with each other—that is, they are phase-connected—in the "bunker," desynchronization emerged over time. Normally, for example, body temperature is lowest in the early morning and highest in the early afternoon; in this way, it proves tightly connected to the sleep-wake cycle. Under conditions of isolation, however, these parameters became unlinked and diverged temporally.

Separate studies that focused on temporal perception also revealed fluctuations of daily periodicity.[20] During waking periods, subjects were asked to press a button whenever they felt that an hour had passed; that is, they were to mark intervals of an hour individually. In addition, either before or after pressing the button to mark an hour, they were instructed to press another button for precisely ten seconds, so that their accuracy in producing a short temporal interval could be measured. As it turned out, the circadian fluctuation that occurred in producing an interval of ten seconds was tied to the daily cycle of body temperature: when body temperature was highest, the shortest interval resulted. If we use the pacemaker-counter model discussed above, elevated temperature leads to a heightened frequency of the pacemaker; this entails shorter durations when temporal intervals are produced, because the number of pulses representing temporal duration is achieved more quickly—further experimental proof of what Hudson Hoagland observed when his wife was sick with fever.

Another picture emerged when participants were asked to identify one-hour intervals: the fluctuations that were measured over the course of the day (the subjects produced markedly different intervals, varying between one and almost three hours) correlated with time spent awake, but not with body temperature. These findings show, yet again, that our ability to identify temporal intervals of different lengths—in this case, the range between a few seconds and an hour—

relies on different mechanisms.

Under more normal conditions of life, the many clocks in the body operate independently, but through pacing effected by light, they achieve synchronization into a stable rhythm that lasts for twenty-four hours. The experimental conditions of the “bunker” demonstrated how important light is for stable periodicity and the synchronization of body rhythms. Other studies have shown that light functions as a pacemaker for mammals, providing the exact rate of timing. Change between light and dark in the environment is registered via the suprachiasmatic nucleus (SCN), a small region in the hypothalamus located above the optical nerve; this ensures the synchronization of the separate physiological rhythms of organs.[21]

We achieve heightened awareness of the steering function that our internal clock performs after intercontinental flights, when we have crossed many time zones. Under these conditions, the timing of our internal clock, which is still “set” to home, and the course of the sun at the new location are phase-delayed with respect to each other. During the day, one is drowsy and incapable of thinking clearly; at night, one sits wide awake in bed. Here, moreover, the rule of thumb for adapting to a new time zone applies: be active outdoors and stock up on as much daylight as possible in order to let the body know what time it is and adjust to the new setting.

Chronotypes: Larks and Owls

Some people go through this kind of phase delay on a daily basis. As holds for all human qualities, circadian rhythm varies from person to person. Accordingly, the internal clock does not “tick” the same for everybody; the rhythm of sleeping and waking can differ markedly between individuals. A spectrum of chronotypes exists, which extends from people who rise extremely early (“larks”) to those who get up extremely late (“owls”). They all display a rhythm that takes twenty-four hours, but high and low points of activity are phase delayed. Early risers grow tired more quickly in the evening, and they go to bed sooner; late risers still feel wide awake at night, and they go to sleep later.[22] This leads to problems for people who get up extremely late. All human beings, irrespective of chronotype, need eight hours of sleep (give or take an hour). Because society is calibrated to the chronotype of the early riser—school and work start between

eight and nine o'clock, at the latest, and sometimes even earlier (e.g., hospitals and bakeries)—even a moderately late riser must live at odds with his or her inner clock. In this context, Till Roenneberg, a chronobiologist at the Institute for Medical Psychology at the University of Munich, speaks of "social jetlag."[23] Late risers experience desynchronization between their inner clocks and societal structures. Their natural rhythm of sleeping and waking makes it impossible for them to rest early at night; then, the alarm clock wakes them up too soon. For this reason, a sleep deficit accumulates over the course of the week, which can only be compensated in part by sleeping in on the weekend. Research shows that late risers drink more caffeinated beverages over the course of the day (to stay awake) and more alcohol in the evening (to have an easier time falling asleep). These modes of behavior represent typical forms of a self-medication. On the whole, circumstances prove less favorable—in terms of subjective well-being and quality of sleep—for late risers than for early risers.

Social jetlag assumes even more dramatic dimensions for adolescents: for developmental reasons, they are extremely late risers; only after the age of twenty do the interindividual differences emerge that situate adults somewhere on the continuum between early and late risers.[24] It follows that young people—who, for the most part, have to get up before seven o'clock to go to school—are still in a phase that, in physiological terms (i.e., according to their internal clock), amounts to the depths of night. And just a short time later, they're supposed to cram vocabulary and solve equations. Needless to say, this does not mean that scholastic problems can simply be ascribed to conflicts between biological disposition and cultural expectations. Many factors play a role. Although direct connections can be demonstrated between late chronotypes, subjective disposition, and behavior, they are not that pronounced. All the same, research presents a clear picture: a connection exists between chronotype, on the one hand, and forms of behavior to be viewed as self-medication, mental exhaustion, and depression, on the other. Large-scale studies have shown that young late risers, in particular, drink more caffeinated beverages and more alcohol; it is also more likely that they will be smokers. A "small" change might produce a dramatic effect. A long-term study performed in the United States in 1997, which involved shifting the start of classes from 7:15 to 8:40, showed what would happen if school began later:[25] on the whole, these pupils were less sleepy, more alert, and less depressive—and even had better grades over the medium term—than peers who were not permitted to make the adjustment.

Because of the complexity of social interests (e.g., those of teachers, the work schedules of parents), it is probably not realistic to demand that schools start at nine o’clock. All the same, it should be possible not to schedule core subjects before ten.

5 Life, Happiness, and the Ultimate Time Limit

The older we get, the faster time passes. More routine in life makes experiences less intensive; consequently, the mind retains them with less clarity. Since our subjective experience of life and its span depends on memory, subjective time accelerates as routine increases. A fulfilled and varied life is also a long life. This is very important for many people, since feeling time pass also points to its ultimate end.

I am reading these words *now*. I see, hear, and feel *now*. Even when we remember our last vacation or look forward to an excursion tomorrow, memory and anticipation occur *now*. We make plans for the future and recall memories in the temporal dimension of presence. We survey our past life from the perspective of the present and become aware of its span. Viewed chronologically, this lifetime starts with the first memories of childhood; the light of consciousness dawns, as it were, with our first memories. Our feeling for life's duration, for periods of life that have passed, is necessarily a matter of remembrance, too.

The feeling of life as time that is limited points to a markedly existential dimension of experience. Many people report the feeling that time seems to pass faster and faster over the course of life. In childhood and adolescence, summer vacations seemed inconceivably long, and the period between Easter and the end of the school year passed far too slowly. Compared to then, five or six weeks fly by now, in adulthood. Likewise, until early adulthood, the academic year—and certainly several years—counted as significant durations of time. In contrast, colleagues at work are quite amazed when they observe how long they have already been working together and how fast—almost unnoticed—the time has passed. Time, it is generally agreed, seems to go faster and faster as we get older.

If only because it is easy to calculate, a popular explanation for this phenomenon is that the relative value of a year, when compared with one's age, decreases as time increases. A year is one-tenth of a ten-year-old's life; for someone who is eighty, it amounts to only one-eightieth—in this context, it represents a smaller interval. It is doubtful whether calculations of this kind actually provide the basis for how people experience their lifetime; they merely

describe the phenomenon. To explain the feeling of lived time, it makes more sense to consider the dimensions of the past and future. “Time perspective” refers to the concepts of the past, present, and future, which change constantly in the course of life (see chapter 1).

An important factor for understanding the course of time is the past perspective. This has been clearly demonstrated by two large-scale studies conducted with more than 2,000 adult participants, at all stages of life, from metropolitan and rural areas in industrialized countries—Germany, Austria, the Netherlands, and New Zealand:[1] in general, adults feel that time is passing quickly; and the higher one’s age, the faster it goes. Adults in the middle years of life indicated that time accelerates markedly between adolescence and young adulthood; this corresponds to common experience.

That said, it is not impossible that the impression of temporal acceleration may be the result of a memory illusion occurring in people over forty, when they are asked to estimate their own life spans retrospectively. For this reason, researchers compared the responses of people of different ages who were asked about their experience of periods that were the same for all participants: a week, a month, a year, and a decade. Here, too, a correlation emerged between age and the subjective speed of time, even though it was less pronounced: the older people were, the faster they perceived the passing of a decade of life. That is to say: past weeks, months, and years do not go faster as age advances; rather, the decades of life do. Researchers determined that the subjective speed of passing decades increases progressively until the sixtieth year of life, when it reaches a plateau; from about this point on, the subjective speed at which time passes remains stable.

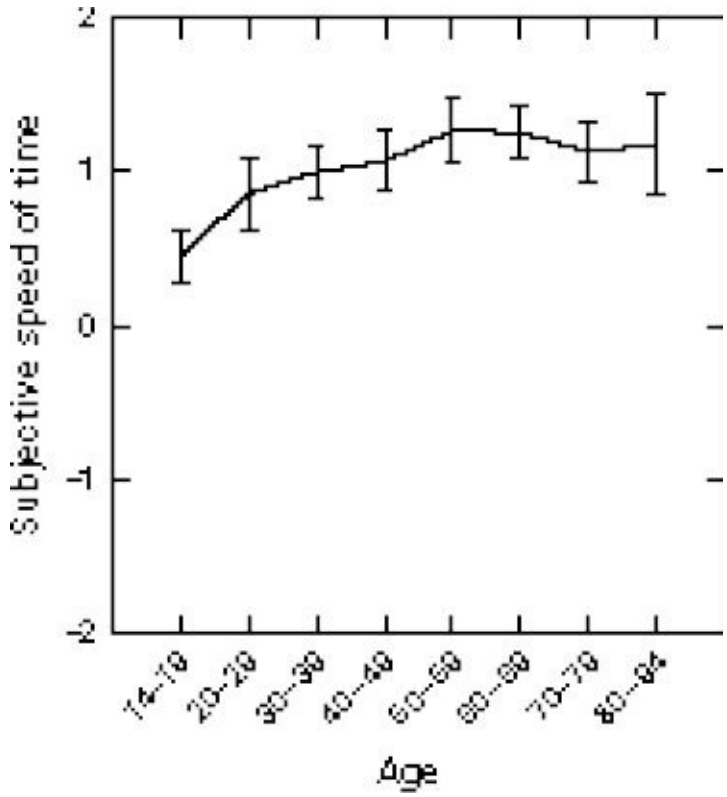


Figure 7
Subjective speed in answer to the question, “How fast did the last ten years go by for you?” Responde aged 14 to 94, were asked to indicate their feeling of time on a scale: –2 (very slow), –1 (slow), 0 (neit slow nor fast), 1 (fast), 2 (very fast). Up to the age range from 50 to 59, subjective speed increases, a which it remains constant.

In sum, studies demonstrate that time passes quickly for adults on the whole, and a correlation exists between age and temporal perception. However, one should also note the broad range of response behavior among participants, which makes it clear that older people, when compared to younger ones, do not necessarily all have the feeling that time is passing more and more quickly.

Numerous studies from the field of cognitive psychology have shown that the subjective duration of a span of time depends on the number of events stored in memory and the number of changes experienced in this period. The more events or contextual changes that occur within a given stretch of time, the longer it is subjectively experienced.[2] Contextual changes concern changes in environment, thought, or feeling. A large quantity of changes perceived over a stretch of time causes duration to expand subjectively, compared to the same span spent under conditions that are monotonous and poor in experience. When a period offers many experiences that can be recalled, it appears to have lasted longer in

retrospect. An exciting week on vacation that yielded many new impressions lasts much longer, subjectively, than a week following the same old routine while commuting between home and the office.

In Thomas Mann's *Magic Mountain*—a novel about how we feel the passage of time, among other things—the "Excursus on the Sense of Time" directly explores how new experiences affect our perception of time. Mann uses the example of the vacation to illustrate how many different experiences during the first few days at an unfamiliar place stretch time in subjective terms. Then, after one has spent a while at the new location, the days shorten in proportion to the effect of habituation that sets in. Finally, toward the end of the vacation, the days fly by as one realizes that the holiday is rushing to a close.

Experiences that are exciting and new expand time. But when what was novel becomes a matter of routine, time starts to pass quickly again. The narration of *The Magic Mountain* also develops on the model of how phenomena of perception and memory unfold over an extended span of time. At the outset, detailed descriptions of the first few days at the sanatorium in the Alps fill page after page. The novel's protagonist, Hans Castorp, views his surroundings and the events there with new eyes, and so there is much that warrants telling. Hours take up whole pages. Later on, the same amount of space is devoted to weeks and even months; far longer stretches of time must pass for the same number of pages to be filled.

Israeli researchers have provided empirical proof for Mann's insight by observing life and the world. At the end of a holiday period, they interviewed people at the beach. The responses provided by forty-one vacationers demonstrated how the time seemed to pass faster and faster over the course of their stay; the first days stretched out, subjectively, and then they grew shorter and shorter.[3] In addition, the researchers showed that people whose professions involved more routine experienced time as passing more quickly than others.

In this context, to fully understand the experience of temporal duration, we should mention the *time paradox*.[4] Temporal duration is evaluated differently depending when the judgment of time is made. A prospective judgment of time occurs when a person estimates the duration of an event while it is still happening. That is, she actively directs her attention to the course of time. We make retrospective judgments by assessing the length of time after the conclusion of an event—that is, by looking back at it. Wholly different cognitive

processes are thought to occur in these two forms of temporal perception. While waiting at the doctor's—when one is paying attention to time (prospective)—half an hour may pass in an intolerably slow fashion. In hindsight, however, it is almost impossible to remember anything, since nothing interesting happened; retrospectively, the span of time shrinks to a negligible quantity. Under other circumstances—say, half an hour spent talking to an interesting person—we are not even aware of the passing of time; in the end, time has gone by far too quickly. But afterward, we can recall so many stimulating moments that the event seems to have lasted a long time.

The time paradox holds for shorter temporal durations—when we first experience half an hour of lived time and then look back at the same interval. However, when it is a matter of evaluating years or decades—as is the case for a lifetime—only the retrospective dimension, that is, the fullness of memory, plays a role.

Fuller Experience Means Longer Life

When asked, older people sometimes express dissatisfaction about time slowing down, which they experience as unpleasant.[5] This seems to contradict what we have assumed until now—that we in fact experience time passing more quickly as we age. However, the matter can be understood in the context of the everyday life of people who do not experience a waking period filled with satisfying tasks; as a result, time seems to trickle slowly (prospective). For example, studies of residents in retirement homes report how the lack of varied activities in a monotonous daily routine leads to the feeling that time is passing slowly—meaning the flow of time over the course of the day.[6] Boredom, in this context, amounts to the feeling that time is passing slowly. Nevertheless, the same people also report that they feel time passing faster and faster as they get older; here, they have years in mind. Accordingly, it is important to pay attention to which kind of temporal experience is being discussed. When periods of life in the past are at issue, people regularly report that time seems to be accelerating.

The development human beings experience over the course of life offers a key for understanding the role that age plays in the sense that time is passing more quickly.[7] From a psychological perspective, childhood, youth, and early

adulthood are phases of life marked by the accumulation of constantly new experiences: the birth of a younger sibling, the first day of school, the first vacation spent without parents, the first kiss, and so on. Three years of childhood mean enormous development and countless learning experiences. A twelve-year-old is still a child, but a fifteen-year-old can be almost an adult. In young adulthood (as a rule), one finishes school and gains independence from one's parents; professional training or college follows; finally, the first real job comes—at the same time, perhaps, a stable partnership. Later in adulthood, in contrast, experiences that are really new decrease; in professional and private life, little change takes place. Three years of adult life often mean three years of routine: getting up, going to work, watching television, sleeping, getting up again, and so on. There is no need for the sameness of experience to be given a separate place in memory. The result is a lower quantity of memory contents; with that, the subjective duration of a given span of time diminishes. The studies of temporal acceleration mentioned above may be explained in this light: inasmuch as people follow more and more routines as they advance in age—experiencing more and more repetition—they encounter and take note of less and less novelty; in consequence, the subjective duration of periods of life shortens.

The finding that only a moderate connection holds between age and the subjective speed of time indicates that no inviolable psychological "law" is at issue. Many studies have demonstrated that the feeling of duration depends on the number of changes experienced and retained by memory; as such, it is possible to influence how time is felt by way of experiences in life. Storing more memories in a given period will result in feeling that a longer time has passed. Here, emotions play a role: events are subject to more frequent and more detailed recollection when they are connected with feelings. In general, we can say that events are stored because they are charged with a certain level of affect.[8] Alternatively, the episodes in our lives that we remember depend on the feelings we associate with them. The greater the store of lived experience—that is, the more emotional coloration and variety one's life has—the longer one's lifetime seems, subjectively.

With this knowledge, we can formulate directions that may lead to changes in our experience of time. In order to feel that one's life is flowing more slowly—and fully—one might seek out new situations over and over to have novel experiences that, because of their emotional value, are retained by memory over the long term. Greater variety makes a given period of life expand in retrospect.

Life passes more slowly. If one challenges oneself consistently, it pays off, over the years, as the feeling of having lived fully—and, most importantly, of having lived for a long time. Nevertheless, one qualification—which seems rather melancholy—must also be made. As a matter of course, even active and flexible people experience the feeling of repetition at one point or another—say, when one travels to the twentieth exotic land or develops the latest in a long series of innovative business ideas. After all, experience means having done things in life, and so many things and events no longer seem unexpected and novel. What stands out are the experiences that occur for the first time; as such, events from the early phases of life prove especially enduring.

Additionally, we must reflect on the value of our experiences. It takes decades of professional experience to yield expertise that proves invaluable. An extreme change in circumstance—say, moving from one profession to another—can render superfluous all the expert knowledge one has accumulated. Accordingly, one's subjective experience of his or her lifetime may involve more than deploying the knowledge and skills one has acquired; the trick might be to use them in different contexts, and not always on the same, well-trodden path.

Sigmund Freud stressed that two aspects of life are essential for mental health: the ability to work and the ability to love. Where the second is concerned, the issue of variety proves rather delicate. It is worth considering that the emotional depth achieved in an intensive and lasting relationship might be preferable—even in terms of accumulating life events and the subjective expansion of a lifetime that this entails—to the alternative: soon enough, a series of affairs and short-term relationships will follow the same scheme. Don Juan is the last person to be able to stop time from speeding up.

When We Are Short of Time

We now turn to the future perspective, which must be viewed alongside reference to the past to account for the phenomenon of subjective temporal acceleration.

One study has shown that a heightened fear of death in women between the ages of sixty and eighty-five leads to a more pronounced sense of time slipping away.[9] It might be that a future perspective, abbreviated by the anticipation of

life's end, accelerates subjective time. Indeed, critical events in life—for example, illness or unemployment—can shorten the future perspective of people of all ages in a single blow.[10] If someone has, say, planned life along the lines of professional training or building a house, the occurrence of such an event will radically abbreviate his or her temporal perspective. Plans now relate only to periods of days or weeks. People with a shortened temporal perspective—which need not stem from sickness or imminent death, but can also result from leaving one's home country (or just familiar surroundings)—change their social preferences; they seek out others to whom they feel emotionally close. Friends and family become more important than adventures in the mountains on one's own.

What is more, the common view one occasionally hears—that older people make fewer plans for the future and tend to "live in the past"—is not tenable as such. Even if findings exist for this thesis and show that less openness and controllability shape the personal future of older people, which can lead to a stronger turn to the past, there is evidence that it is mainly the temporal range of future-reference that decreases.[11] That is, the number of activities planned for the future does not diminish so much as the temporal interval for which plans are made. Increasingly, long-term plans that span many years and are natural in young and mid-adulthood are replaced by activities that concern the nearer future. Analysis of the intentions of people who are quite old still indicate a large number of anticipated goals. Thus, a pronounced future perspective (even if it is shortened in old age) is connected with personal well-being. The thesis has been refuted that old age entails a crisis in which temporal perspective changes abruptly. As a rule, continuous adaptation to changes in conditions of life shapes the aging process. To be sure, in advanced adulthood, the perception of life's finitude can play a stronger role. For all that, however, the question of finitude and death does not seem to take precedence in older people; this was determined by the Bonn Longitudinal Study on Aging, in which the same group of people was interviewed as they aged over the course of decades.[12] On the whole, problems relating to practical matters of life proved of greatest concern. In everyday life, the subject of death does not necessarily occur to older people more than to younger ones; rather, certain borderline situations—for instance, serious illness—bring the matter home and can prompt a sense of approaching death.[13]

For older people who are healthy, the subject of death does not predominate—

at least on a conscious level. The thought of death typically does not represent a stress factor that would point to time running out and therefore lead to a heightened sense that time is accelerating. Moreover, such a notion cannot explain why the increased acceleration demonstrated in the studies mentioned above occurs at mid-adulthood, and not later. Even fraught experiences such as "midlife crisis," which can grip people between the ages of thirty-five and fifty and involves an awareness that one's time is limited,[14] cannot explain the gradual acceleration of subjective time as the stages of life unfold. After all, a steady subjective acceleration can already be noted prior to this point—between adolescence and early adulthood, in one's twenties and thirties.

How, then, may these scientific studies be summarized? In the first place: at least in industrialized nations, people demonstrate the feeling that time passes faster and faster with age.[15] Second: studies confirm that subjective temporal duration is decisively shaped by the degree of novelty and emotion in experiences, which determines the amount of memory storage concerning periods in the past. Third: it is possible—even if there is still no hard proof—that the experience of time accelerating with age depends on memory. Because of increasing routine and the decreasing novelty-value of experience that this entails, time seems to accelerate subjectively as fewer and fewer memories are stored over the course of a life.

Death: Experts, Deniers—and Investigators

As one may gather from the Bonn Longitudinal Study of Aging, the theme of death and dying does not stand in the foreground for older people. At the same time, and counter to widespread claims, the matter is not taboo when it comes up in serious conversation. When asked, people are ready to share their thoughts on the subject. In the context of a sociological study about conceptions of death, 150 interviews were analyzed, and three kinds of discourse emerged.[16] "Death experts" have a clearly defined image of death, which may be religious in nature or, for that matter, cast in atheistic terms. In either case, death calls for no further investigation because the "experts" consider the answers plain enough: the religious ones know that God exists and there is life after death; the others know that nothing follows biological death. Decidedly religious individuals and atheists hold to an unwavering position that precludes further discussion.

In contrast, for “deniers,” the subject of death is not a topic at all. They are concerned about the health and physical well-being of themselves and their children. They focus on life and avoid talking about death. If these were the only two ways of dealing with the matter, then death and dying would hardly come up at all; death-denial theorists would feel their position confirmed in every respect. However, a third group exists: “death investigators.” These people openly ask themselves questions about death; they feel challenged by death and actively seek answers. As one might expect, sociological analysis of the ways people deal with the meaning of death offers a heterogeneous picture. There are true deniers, but there are also people who confront their mortality out in the open.

What does it mean, then, when the taboo topic of death is mentioned? The psychoanalyst Otto Rank made the ways human beings deal with death the central theme of his study, *Psychology and the Soul*.[17] The idea of the soul’s immortality, he argues, arose in response to our latent fear of death; monotheistic religions, which promise life after death, emerged from this impulse.[18] At first, this idea does not seem terribly original, but Rank goes further. As he views it, unconscious forces prevent individuals from thinking about death. Society has created mechanisms, forms of cultural adaptation, that are meant to keep people from becoming conscious of their creaturely (animal) nature—and, therefore, their mortality. Societal taboos and the privatization of biological needs follow from the fact that human beings—just like the neighbor’s dog—have a digestive system and sex drive. Everything about us that might implicate creatureliness and mortality is covered by a cultural “shield.” This may involve religious practices that debase our physicality and exalt our spiritual dimension. For Rank, culture expresses unconscious forces that repress our fear of death.

The Art of a Long Life

Death is quite the popular topic—so long as it is somebody else’s. This much is made plain by the high print runs of detective stories and the success that shows such as *CSI* have enjoyed for many years. Reading tales of crime in a warm bed or on the sofa often produces a pleasant shudder. When one sits by a roaring fire while a winter storm rages outside, the distance between one’s own safety and danger is palpable. One gets the impression that we learn, from reading accounts of murder, how to face death and dying without danger. The case is almost

always solved; things end well with regard to the circumstances of death and the guilty party. Often, the guardians of the law display very human qualities. You can easily identify with the frail, older private detective or the clueless police commissioner who are not unreachable superheroes. One might say that the appeal of murder mysteries lies in the effort to uncover the secrets of death. In fiction, a mystery can be solved that defies explanation in real life.



Figure 8
Ignaz Günther (1725–1775), *Chronos*, Bavarian National Museum. The work unites time and death in figure of Chronos, illustrating how the experience of time points to life's finitude.

Anyone who finds this interpretation somewhat far-fetched may consult the dream theory of the Finnish philosopher and neuroscientist Antti Revonsuo.[19] According to Revonsuo, dreams are simulations of taxing situations in life: missing trains and planes, forgetting notes for an important presentation,

accidents, and falls. Dream narratives simulate real life in a “safe setting” and help people adjust emotionally to similar occurrences. Of course, dreams may be interpreted in many ways, just as one might read a detective novel for different reasons. But one function such stories perform might be to simulate encounters with death and dying without risk: ultimately, the fiction promises to explain the mystery of death.

That said, if it is not dressed up in criminological literary attire, death hardly represents a popular theme, except to philosophers and those among us whom sociology identifies as “death researchers.” Otto Rank would probably argue that even such anomalous individuals are repressing their actual fear of death. On the one hand, these individuals might be trying to achieve a sense of immortality by producing philosophical treatises; on the other hand, a courageous encounter with this weighty matter might make them feel heroic. Just how bold one is can be determined only on a concrete and individual basis, when we actually have to face dying and it is no longer a matter of books and coffee-house discussions. Empirical investigations related to the “terror management theory” provide evidence of repressed thoughts about death that are revealed through cleverly devised manipulations in psychological experiments.[20] Still, it is difficult to know whether death is in fact repressed in life, at least by a majority of people. To put things in the terms of a common critique of psychoanalysis: if we do not agree with the theory of death repression, this is sure proof that it exists.

In his essay *On Death*,[21] the philosopher Ernst Tugendhat steers the opposite course. According to Tugendhat, no autonomous force (unconscious process) represses death; instead, a positive force oriented on life acts on people, making everyone the center of his or her own world. Human beings are suited for life only inasmuch as they possess the will for self-preservation. Accordingly, humankind is focused wholly on life. The matter of death comes up only rarely because we, as biological entities, are designed for survival. We direct our attention to everyday concerns and, in the process, disregard death; there is no need to practice repression actively.

Carpe Diem! The Key to a Long Life



Figure 9
Luca Giordano, *La mort de Sénèque*, 1684; see note 23 to this chapter.

The brevity of life and dealing with the inevitability of death are one thing. Another is what each person does with the time she or he is given. The Roman statesman and philosopher Seneca got to the heart of the matter in his work *On the Shortness of Life*:

> It is not that we have a short time to live, but that we waste a lot of it. Life is long enough, and a sufficiently generous amount has been given to us for the highest achievements if it were all well invested.[22]

Born in the first century of the Common Era in Cordoba (Spain), Seneca was a highly respected Roman intellectual of his day.[23] All the same, his reflections seem to be modern: his words of caution and exhortation apply to our conditions of life, too. The Stoic makes fun of people who run around pursuing matters they think are important yet always remain dissatisfied. “Salvation” is expected of the time after retirement; then attention will really turn to living:

> You will hear many people saying: “When I am fifty I shall retire into leisure; when I am

> sixty I shall give up public duties.” And what guarantee do you have of a longer life? Who will allow your course to proceed as you arrange it? […] How late it is to begin really to live just when life must end! How stupid to forget our mortality, and put off sensible plans to our fiftieth and sixtieth years, aiming to begin life from a point at which few have arrived!

The Stoic’s moralistic finger is clearly wagging. Indeed, as the empirical studies mentioned above have demonstrated, one often fails to consider one’s own mortality. Research has confirmed the negation of life’s finitude that Seneca addressed—which occurs even at an advanced age. Moreover, in Seneca’s opinion, life only seems short to us—that is, to pass faster and faster—because we waste time on so many useless activities. “Useless” does not necessarily mean lazy Sunday afternoons on the couch. Seneca endorses anything but an unconditional work ethic. On the contrary, he wants to demonstrate that many of our pursuits in life—and especially the work we choose, which eats up all our time—keep us from things that would really prove fulfilling and offer an emotionally rich existence. At this juncture, the reader may reflect on his or her own activities. What is keeping us from doing what we really want to do? In other words: life is, in fact, long, if only we know how to use our time. In the language of memory psychology: Live in such a way that your life is varied and emotionally rich; then you will live for a long time.

6 Winning and Losing Time: The Self and Temporality

In this chapter, I present a new solution to the mind–body problem: self-consciousness—achieving awareness of one's own self—emerges on the basis of temporally enduring perception of bodily states that are tied to neural activity in the brain's insular lobe. The self and time prove to be especially present in boredom. They go missing in the hustle and bustle of everyday life, which results from the acceleration of social processes. Through mindfulness and emotional control, the tempo of life that we experience can be reduced, and we can regain time for ourselves and others.

Perception necessarily encompasses the individual who is doing the perceiving. It is I who perceives. This might seem self-evident. Perception of myself, my ego, occurs naturally when I consider myself. I "feel" and think about myself. But who is the subject if I am the object of my own attention? When I observe myself, after all, I become the object of observation. Clearly, this intangibility of the subject as a subject—and not an object—poses a philosophical problem: as soon as I observe myself, I have already become the object of my observation.[1]

Even if we steer clear of the problem from the perspective of the subject and focus, instead, on perception and its object, it is impossible to avoid speaking of an "I." This occurs even when perception is not of me, but of another object in the world. Perceptions that are present to the senses—that is, visual and auditory impressions, as well as feelings, such as pleasure and pain—necessarily involve someone who has them. As Lambert Wiesing, a German philosopher in Jena puts it:[2]

> Because my perceptions exist, I must exist, as the one who must be there as the subject of these perceptions in a real world.
>
> For something can only be present if there is someone for whom it is present.
>
> The perceiver cannot be separated from his perceptions.

As phenomenological philosophy has determined, self-consciousness is not a mental state that is added on to our experience, or that is particular; rather, it is a

feature inherent in all experience.[3] My perception contains *me*. For all that, the subject cannot provide a phenomenal object for observation. It is not a thing in the world to be measured. Nor is it a phenomenon to which qualities may be ascribed. The Scottish philosopher David Hume (1711–1776) pointed out the problem when he noted that among all the perceptions he had, he could find no "I." Accordingly, Dan Zahavi, a philosopher from Denmark, has suggested that one should speak not of the "subject" of experience but of the "subjectivity" of experience, to avoid the problem that arises from positing the subject as an object.[4] The framework of subjectivity precludes isolating an ego-object and observing it separately; all the same, the ego is part of experience. Wiesing puts it somewhat differently: although an ego occurs in perception, it does so "not as a subject of substance, but as an ego-pole in a constellation."[5] This constellation refers to the *intentionality* of consciousness, as posited in particular by Edmund Husserl: consciousness is directed at a state of affairs. That is, the subject focused on an object is not itself an object of perception. On this view, subjectivity is part of the intentional act of perception.

But what, then, is the ego? After all, I experience myself as a thinking, feeling, and acting human being. I exist, after all: there is something that is *me*. The conscious feeling of the self is fundamental, and draws on a sensation of physical presence as well as narrative elements—my personal history. In keeping with the view that it is more accurate to speak of subjectivity than the subject, one might employ the terminology of Thomas Metzinger, a philosopher in Mainz, and say that the self is not a thing so much as a process.[6] According to Metzinger, subjective experience—the self—arises from complex patterns of neural activation in the brain. That is, the ego is not a material entity; instead, it is the result of a number of processes. On this model, the brain creates a model of the ego.[7] This is how I recognize myself.

On the phenomenal level, consciousness—and the self-consciousness deriving from it—is distinguished by spatial and temporal presence. Consciousness is tied to corporeality and temporality: I experience myself as existing with a body over time. In the language of brain research, the *now* provides the frame of temporal reference for manifold cerebral processes that need to be synchronized.[8] To make unified consciousness possible, our cerebral processes, which are dynamic and distributed in space, are connected with each other and operate on a temporal continuum. I experience myself now as an embodied entity, but I also

experience myself as persisting in time, beyond the moment:

> For the perceiver, [perception] is … bound up with the necessary certainty of having to be a spatial something in time and a temporal something in space.[9]

Research on consciousness inevitably shows that our concepts of self, time, and body are interrelated. Presence means becoming aware of a physical and psychic self that is temporally extended. To be self-conscious is to recognize oneself as something that persists through time and is embodied.

The Global Emotional Moment

Upon reflection, the fact that we possess self-consciousness is astonishing. When a human being becomes aware of itself, nature becomes aware of itself. “Nature opens her eyes in humankind and notices that she is there.”[10] This thought might make one shudder. Through me, nature recognizes that it exists. The world sees and acknowledges itself. This represents a starting point for philosophical reflection. At the same time, it offers natural scientists the basis for understanding how self-awareness arises in nature. Since we are natural beings, neurobiology can investigate, within its natural borders, how consciousness of the self emerges: what cerebral processes are involved? The neuroscientific account should include the factors established by phenomenological analysis. We need to identify the neural processes that underlie our perception of our bodies and time. Presence, on a basic level, is temporally extended bodily awareness. Likewise, consciousness of oneself as a psychological entity is tied to one’s experience of duration. I perceive myself as persisting in time. Self-consciousness, as a process, involves the emergence and preservation of temporal and physical presence. To put the question in other terms: where in the brain, and through what processes, do perception of one’s own body and the experience of temporal duration—which yield the sense of self—occur?

It should come as no surprise that no unanimous opinion (i.e., no theory) holds for this question. Who would presume to have grasped the neural foundations of consciousness? That would mean solving the soul–body problem—or, as scientists now call it, the mind–body problem. The book at hand will propose a new idea. For all that, there is as yet no consensus on how and where consciousness arises in the brain. Indeed, many philosophers and neuroscientists

would say that they cannot even begin to understand this question.

Nevertheless, we know of limit conditions that must hold for consciousness to be possible. For example, a certain minimum of cerebral activity must occur. Thus, the reticular activating system, *formatio reticularis*, which ascends over the brain stem and thalamus to the cerebral cortex, maintains the cortical tone, which enables alertness as well as goal-directed orientation in time and space.[11] Therefore, injury to the anatomical structures of the *formatio reticularis* results in impairment of the waking state; grave injury leads to coma. As such, the activation-function of the *formatio reticularis* provides a necessary, if insufficient, condition for consciousness.

The neurologist Antonio Damasio has made one of the more notable recent contributions to understanding how features of the brain relate to processes of consciousness.[12] For him, the regions and operations of the brain that process the body's signals are of primary interest. On a fundamental level, interoception (inner perception)—perception of the body and bodily functions—represents a stable reference for awareness of the self, which Damasio calls *core consciousness*. Damasio's reflections also incorporate a further factor: the dependency of our emotions on physical states. This is why, colloquially, a strong connection exists between our feelings and the way we describe our bodily states: we speak of butterflies in our stomach and trembling knees when we are in love, disgust that is nauseating, and fear that makes our heart jump into our mouth. On a basic level, feelings relate intimately to feedback about physical states that are situated somewhere between excitement and relaxation. At a higher level, thoughts and motifs combine with basic bodily signals and are expressed as positive or negative feelings. As Damasio demonstrates, feelings that adapt dynamically to situations and inner physical conditions offer the most convincing indications of a person's state of mind. Patients experiencing a clouded state of consciousness often show no emotion; their faces appear stony and empty. According to Damasio, core consciousness depends predominantly on areas in the upper brain stem but also the insular cortex—that is, the regions that process bodily signals.

The insular lobe or insular cortex—or simply *insula* (which means "island" in Latin)—forms part of the cerebral cortex in mammals. The *insula* is the main cortical area and is responsible for bodily perception (interoception). Related to the term exteroception—that is, the perception of objects in the outside world—Charles Scott Sherrington (1906) and, later, Bud (A. D.) Craig and others

developed the concept of interoception: the perception of physical signals that are integrated in the insular cortex. In this context, bodily perception includes temperature, touch, pain, itching, and tickling; sensations in the muscles and intestines; feelings of hunger and thirst; and the need to catch one's breath after exertion. The thalamus counts as the gateway of consciousness inasmuch as signals from all the senses, with the exception of the olfactory system, reach the cerebrum via the thalamic nuclei. From there, the body's signals reach, among other areas, the posterior parts of the insular cortex, where an initial determination of the body's physiological condition is made.[13] However, conscious experience does not yet follow from this first level of processing of bodily signals in the cerebrum. According to Bud Craig at the Barrow Neurological Institute in Phoenix, Arizona, conscious experience develops through further processing of the signals, which occurs in stages passing from the posterior to the anterior parts of the insular cortex (see figure 10).[14] In the course of this operation, bodily signals are integrated with processes of thinking and feeling that are fed by neural signals from many other areas of the brain to which the insular cortex is connected. By means of this integration, the perception of the physiological condition of the body is coupled, step by step, with what the external senses register: social circumstances, thought-processes, and motivational states. The integration of signals culminates in the anterior insular cortex, where all relevant information concerning the current situation is combined into a complex whole.

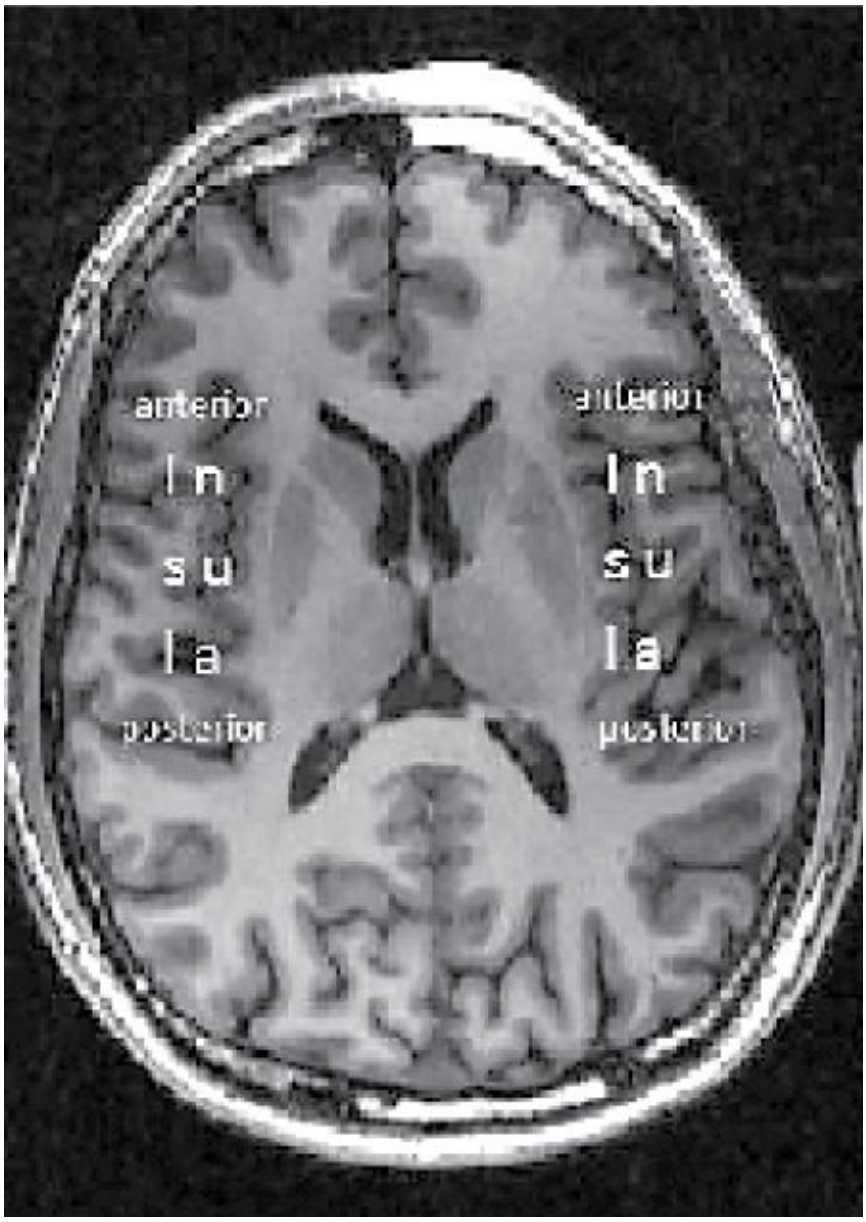


Figure 10
An image of the author's brain, obtained by means of magnetic resonance imaging (MRI). This "br slice" shows an axial plane (viewed from above). The insular cortex is the structure arranged in gemin fashion, with pronounced folds. Neural cells are located in the darker areas. The nerve fibers connect neural cells comprise the lighter substance. Functionally, bodily signals arrive in the posterior insu cortex and, in further stages of processing, are conducted forward (to the anterior region).

The integrated representation of all sensations has been christened the *global emotional moment* by Bud Craig. It is the "I" felt in this particular moment, both bodily and mental presence. This all-encompassing emotional moment is created through processes of the brain; it is tied to the processes that converge in, and

then diverge from, the anterior insular cortex. On the phenomenal level, subjectivity emerges: I perceive myself as a feeling subject in the environment. At every temporal instant, I, as the subject of perception, am tied into a series of moments that have already passed and moments that are anticipated. Self-consciousness results inasmuch as I mirror myself in the past and project myself as an agent into the future. Self-consciousness first emerges through these temporal relations.[15]

Accordingly, self-aware experience arises through the simultaneous occurrence of emotional moments of an integrated self over time, a process tied to operations in the anterior insular cortex. I do not simply see a computer screen in front of me (that would be a description of the visual field); rather, I find that I am sitting on a chair, experiencing a slight sense of hunger, while feeling positively motivated to write about how consciousness comes about. The human being achieves self-awareness—an ego emerges—through neurophysiological processes culminating in the anterior insular cortex. Or, to retain the philosophical terminology used above: subjectivity emerges.

An Answer to the Mind–Body Problem?

To anticipate a common objection to this way of conceiving the relationship between brain and consciousness: self-consciousness is not strictly located in the anterior insular cortex. Consciousness does not “sit” in these convolutions of the brain. Instead, the neural signals distributed throughout the body as whole are conducted, via an array of processing levels, to the insular cortex. Here, the signals are processed, step by step, in a series of further interactions with signals from other parts of the brain until they reach the anterior insular cortex. The result of these complex processes is the generation of a subjective feeling of presence—or, as Craig puts it, the global emotional moment.

But that’s not all. Just as the processes in the anterior insular cortex are connected with the perception of one’s momentary condition, processes in a structure situated nearby initiate reactions to the perceived state. Ultimately, the function of basic bodily sensations yields the homeostatic control of physiological states. *Homeostasis* is the self-regulation of the organism, which serves to produce a dynamic equilibrium. I realize that I am thirsty, so I drink. If I am hungry, I eat. If I get too hot, I look for a place in the shade. By means of

the function performed by the insular cortex, which indicates a feeling corresponding to the state of the body, an action is set in motion. In this way, structures in the anterior cingulate cortex (ACC) “translate” the representations of physiological conditions into instructions for action.[16] Attention is directed to the problematic state, which triggers bodily reactions. On the physiological level, this occurs as a reaction of the autonomous nervous system. The organs adapt to the situation. On the level of behavior, it takes place as complex motor operations. One reacts to thirst by reaching for the water bottle. Studies on the perception of emotions that use imaging technology such as functional magnetic resonance imaging (fMRI) show the close functional connection between both regions: the anterior insular cortex and the anterior cingulate cortex are activated simultaneously. This indicates that both regions steer self-regulation processes in the organism in conjunction with each other.

It is interesting, in this context, that many psychiatric maladies—such as drug addiction and anxiety disorders—can be described as disturbed homeostatic processes, as Martin Paulus at the University of California, San Diego, has postulated.[17] Drug addicts display an abnormal urge for a substance to procure a physiological state of balance that addiction has massively altered. The same holds for relatively healthy people every day: people who are used to strong morning coffee will have a hard time if they do not get their regular dose of caffeine. Some will even say they are incapable of working without coffee. A wide gap separates the desired condition from the current state.

States of fear that are classified psychiatrically may be described as overly strong reactions to insecurities in life. Avoidance behavior in certain situations—for example, not attending a colloquium out of fear of public speaking—means that the future situation, which is filled with fear (the anticipated condition), differs too much from the desired condition (which is experienced now). At this point, the insular cortex and bodily feelings come into play. According to the model developed by Martin Paulus and Murray Stein, activity in the anterior insular cortex is necessary to balance out the *now*-feeling and the imagined feeling of the future situation (speaking in public).[18] In patients with anxiety disorders, the imagined state of fear deviates markedly from the momentary condition, which is not fearful. Consequently, the discrepancy leads to phobic reactions such as avoidance behavior.

Indeed, studies have repeatedly demonstrated that patients with anxiety

disorders display greater activity in the anterior insular cortex than those in the control group. Accordingly, the feeling of fear is the corollary of heightened activity in the insular lobe—a further connection between phenomenal perception and neural activation in those parts of the brain responsible for the perception of body and feeling. Incidentally, a pronounced connection between phenomenal perception and activity in the insular cortex has been demonstrated with temperature stimuli:[19] the higher the subjectively estimated temperature, the stronger the activation of the right anterior insular cortex measured by the fMRI. This is noteworthy insofar as the physical temperature correlates with activity in the posterior insular cortex. Activity in the posterior insular cortex therefore represents a physiological reaction to physical changes in temperature, and the anterior insular lobe corresponds to subjective (phenomenal) experience of temperature.

Despite the solution to the mind–body problem proposed here, though, a fundamental question persists. Even if a close connection between phenomenal consciousness and neural processes involving the insular cortex should prove to hold and even become part of the canon of neuroscience, an explanatory gap remains: no one knows how to represent the way that neurophysiological events yield the subjective quality of perceptions and feelings.[20] This puzzle, known as the *qualia problem* in philosophy, holds that even if we completely understood how the brain functions, we still could not explain how the phenomenal contents of consciousness (*qualia*) come about. Even though phenomenal consciousness may always be correlated with certain processes in the brain, these neurophysiological events (which involve neural systems, transmitters, synapses, etc.) are something wholly different from my feelings. Many philosophers contend that this gap is unbridgeable in principle.

In this context, we should note a recent neurobiological discovery. Neuroanatomists have linked very specific brain cells, so-called von Economo neurons (VENs), to consciousness.[21] VENs occur with particular frequency in the anterior insular cortex and the anterior cingulate cortex. On the one hand, these neurons are easily identified by size; they are larger than the surrounding nerve cells (the pyramidal cells). On the other hand, they are spindle-shaped, with two branches arranged in polar relation (dendrites) extending from the cell body. Researchers have determined that VENs occur only in more highly evolved mammals who display self-consciousness: animals capable of complex social interaction. Great apes, in particular, have been shown to have VENs. As

the degree of kinship between great apes and human beings decreases, so too does the number of VENs. Chimpanzees and bonobos have more of these neurons than gorillas, who in turn have more than orangutans. However, VENs have also been found in whales and dolphins, as well as elephants. Researchers have determined that all of these animals can pass the “mirror test”: when a dot is applied to a site on the body that can only be seen in a mirror—say, the animal’s forehead—the animal will take a long look and try to wipe it off. Accordingly, these animals have a concept of self: they recognize their counterpart in the mirror as themselves. Members of other species, in contrast, confuse the image with another of their own kind; they try to initiate contact or make threatening gestures. Von Economo neurons, situated in the anterior insular cortex and the anterior cingulate cortex, might be decisive for the emergence of consciousness.

Boredom—Agonizing Time and Self

A memory of mine from Hong Kong: on one of the picturesque mountains over which the city extends—overlooking the bay, the sea of skyscrapers, and the forested islands—stands a park; here, there is a simple cage, maybe five by five meters. A lone chimpanzee is the occupant, sitting on a rubber floor with nubs. I can no longer recall the details, but the cage contained few objects for the animal’s entertainment. I watched the chimpanzee for a few minutes. He seemed to be lying down more than he was sitting. His fingers toyed apathetically with torn nubs, performing repetitive motions. His eyes stared listlessly at the floor. I thought I heard a sigh. I was filled with empathy, for I understood that the chimpanzee was bored.

There is always a risk of anthropomorphizing animals, that is, conferring human traits on them. However, research conducted in the last few years indicates that the chimpanzee, as a self-aware animal, is capable of feeling a kind of boredom, experiencing the passing of time in a way that approaches what human beings feel.

A human prisoner who spends his days in an overly predictable routine with monotonous surroundings feels boredom to an extreme degree. That said, for many, a Sunday afternoon can lead to a similar state.[22] Time passes much too slowly. In a negative sense, to feel bored is to feel acutely the proximity of time

that refuses to pass. Nothing is stimulating. One experiences an uncomfortable proximity to oneself but does not know what to do with oneself. Boredom involves becoming directly aware of the fact that one is trapped in time. This description brings together the perception of temporality and subjectivity. As a matter of self-regulation, the condition itself practically screams: "Do something!" Indeed, boredom often leads one to avoid or abandon activities that are boring. The only problem is that, on this sluggish Sunday afternoon, I cannot abandon myself. Even the idea of going to the movies or meeting with friends holds no appeal.

My boring Sunday afternoon makes me become aware of myself and time. Neurobiological findings and phenomenal analysis of self-consciousness suggest that the feeling of boredom correlates with pronounced activity in the anterior insular cortex. All the phenomenal factors that have a demonstrated relation to the insular cortex also occur in boredom: in general terms, physicality and emotionality, and, in particular, a heightened sense of subjectivity and temporality. To put things in the terms of the philosophical dictum above, one might say: through boredom, nature achieves wholly unpleasant self-awareness.[23] The feeling is attended by intensified self-perception, but also by a feeling of emptiness. It is as if the object of reflection (my ego) were empty, even though subjectivity intensifies as this void is perceived.

Acceleration—How We Can Retain Control Over the Pace of Life

If boredom means too much time, what does too little time mean? If boredom, as time that is felt, is accompanied by an intensified sense of *self* that proves unpleasant, then the feeling that there is not enough time should lead to a less intense experience of the self. Martin Heidegger (1889–1976), who equated time and self in his philosophy[24] and focused on the subject of boredom in a lecture,[25] addresses the common complaint of "having no time":

> This *not having any time* is ultimately a *greater being lost of the self* than that wasting time which leaves itself time. Perhaps there lies in this having time a far greater balance and thereby security of Dasein—a being-alongside-oneself [*Bei-sich-selbst*] that at least *has an intimation* that what is essential in Dasein cannot be forcibly brought about by any busyness or mad rush. … The "having no time" that looks like the most rigorous seriousness is perhaps the way in which we are most lost in the banalities of Dasein.[26]

In essence, this means that if one has no time, one has also lost oneself. Distracted by the obligations of everyday activities, we are no longer aware of ourselves. If we rush from one thing to another and don't miss a single event scheduled for our free time, we will accumulate many experiences. Yet if we never allow ourselves to calm down but always set out immediately for the next activity, the danger emerges that we will lose ourselves senselessly in a mad rush. In keeping with the philosophical reflections offered above, this means: no time, no self. Most recently, this topic—as well as the issue of a "time crisis"—has been discussed in the context of society and technology; see, especially, *Social Acceleration* by the sociologist Hartmut Rosa.[27]

According to Rosa, the ubiquitous acceleration of processes represents a fundamental principle in our society that the individual cannot escape. First and foremost, there is technological acceleration. Prime examples include washing machines and dishwashers—devices that should actually relieve people of temporal burdens. Likewise, instead of voyages taking days or weeks—as was still the case in the mid-nineteenth century—modern means of transportation have shortened travel time to anywhere in the world to a matter of hours. But the situation proves paradoxical. All this time gained does not result in the feeling that we have more time. On the contrary, the universal lament is that we "have no time." This is surely the result of technological advances that enable us to undertake more and more activities per day; the time we've freed up is filled with even more activities and deadlines.

In addition to technological acceleration, the pace of life is speeding up.[28] Tasks must be performed within certain periods of time. The sentiment voiced on all sides, however, is that these periods are getting shorter and shorter. The universally expressed feeling is that the segments of time demanded are becoming shorter. Pressure is mounting. It is difficult to relax during coffee breaks at the office if work will only resume at a breakneck pace. Accordingly, the break often gets cut short so that we have more time to attend to various duties that remain unmet. You feel you are constantly under pressure to get things done quickly. More still, expectations change through technological acceleration. It used to be that I would answer letters after a few days—if not weeks. Today, email demands a response within minutes, or at very least on the same day.

A corollary of accelerated cycles of life is the sheer abundance of information available all at once—as well as the array of options for activity that this entails.

We might be able to do more and more things simultaneously, but nothing gets done properly. While we prepare a meal, the television demands our attention; we dash off our emails during phone conversations. Activities are switched into parallel mode. The simultaneity of activities results in inadequate processing depth.

Critical views of modern society describe a broad conceptual arc. They begin, on one end, with philosophical analyses of temporality and the self. They end with diagnoses of social conditions. Critics of acceleration maintain that accelerating patterns of life are the reason for a commonly voiced sense of unease—the feeling that one is not "really" living. Everything is done all at once, faster and faster, yet no personal balance or meaning can be found. This implies the loss of contact with one's own self.[29] We also no longer feel "at home" with ourselves and find it difficult to persist in any given activity because we are available at every moment; the phone always rings at the worst possible time.

In view of this diagnosis, it is certainly not a mistake to try to relax one's relationship with the culture of acceleration. At any rate, this is preferable to falling prey to frenzied activity yet again and then booking an expensive meditation retreat! Chapter 3 discussed a possibility for acquiring mindfulness: living in the moment. Small changes in the attention we pay to what is happening to us offer the key to having a sense of control over patterns and cycles in everyday work routines. My point is hardly to offer an instruction manual for how to use one's time; suffice it to say that time-management is, in essence, and contrary to suggestions of many books on time-management, making wise use of oneself and one's feelings. Work to be done as quickly as possible, which seems like a mountain, sometimes shrinks, upon closer inspection, to a hill that is easier to climb—if we recognize that our emotionally colored associations are the real burden. Might it be my coworker—and not the difficulty or quantity of work—that makes me uneasy about tomorrow's deadline? The strong discrepancy we feel between an unpleasant situation anticipated tomorrow and relatively relaxed circumstances now is what creates the sense of temporal overload. Our imagination—not just reality—can also make us feel pressed for time. Like the social inhibitions most people experience when they go to a party where they do not know anyone, feeling pressed for time professionally often breaks down into emotionally charged ideas about the work to be done.

One can train oneself in mindfulness to experience the moment more intensively and learn the real reason for emotional reactions and automatic thoughts. Via the feeling of emotional self-control, we can achieve a sense of "deceleration." The process is similar to learning a foreign language: at the beginning of our studies, when we hear the language spoken by native speakers, it seems terribly fast. Later, as our competency increases, the tempo we perceive lessens considerably. An increased feeling of control when dealing with the demands of a situation can slow down the perceived tempo of processes.

Fundamentally, the key to a relaxed attitude involves controlling external demands. Stress does not follow from the quantity of work per time-unit so much as from the fact that the work is imposed—without our being able to control it. This is evident, for example, in the fact that work-related stress is experienced more acutely the lower one stands in the professional hierarchy.[30] Even though the amount of work and demands on time tend to increase the higher the position held, physical and psychological stress reactions decrease the more one ascends professionally. This is because, at lower levels in the hierarchy, the work is more often imposed by others. It is easier for the boss to divide his time according to the motto of organizational psychology: "One thing at a time." In contrast, a secretary, although still busy completing an earlier assignment, will often be given a new job to do right away. The situation is only worsened when people in leadership positions display deficient social skills; this entails an additional emotional charge to the way the work tempo is perceived.

At the risk of seeming to provide a how-to manual on gaining control over the pace of one's life, I offer a few tips.[31] A little "timeout": a necessity for smokers—stopping work every now and then for a cigarette outside—should be taken advantage of by nonsmokers. For a few minutes, one can escape the hamster wheel of contacting clients, making calls, reading and answering email, and working on spreadsheets. Take a deep breath; let thoughts come and go. Ritualized pauses during the day's business help one regain one's bearing. Breaks can also function as a latency period for thinking. The best ideas always come when one is not thinking about the problem directly. Breaks offer a pause for reflecting in the back of one's mind. It just might become clear what one's real priorities should be. All of a sudden, the hulking mass of work becomes manageable.

Business people sometimes speak about how, on their frequent travels, they wake up in the morning and do not know which city they are in. Thanks to

airplanes, it takes only a few hours to arrive anywhere on the globe. Then, after a day or two, another trip leads somewhere entirely different. Leaving from London, after a mere ten hours, one finds oneself beyond the Great Wall, headed toward Beijing—a veritable technological wonder of speed. Still, this leaves ten hours for the traveler to adjust to a new world. One need not watch the mediocre film on the tiny onboard screen; this time may be spent intensively studying the culture at one's destination. Likewise, traveling from Philadelphia to Boston leaves plenty of time to focus on the journey and the destination: a chance to concentrate.

Another load factor is the temporal overlapping that occurs between work and free time. Magazines often report that the separation between professional obligations and free time no longer holds for creative and independent people. This circumstance does not necessarily seem taxing (at least for a while), since it entails self-determination, and every working minute can mean more recognition and money. However, for those of us with fixed schedules and pay, it is healthier to switch off the business phone when the working day is done and to read professional emails only at work. At home, with work over and done, what reason is there—once the children have been put to bed—not to spend an hour, every evening, doing *x*? *X* might stand for whatever holds personal interest: reading Proust's *In Search of Lost Time*, spending time on a collection of interesting objects, taking a nighttime stroll on one's own or with one's partner. Do one thing, with full attention, for an hour a day. Or just spend fifteen minutes sitting on the sofa and don't do anything for a change: How's my posture? Does anything hurt? How do I feel? We can give free rein to fantasy and observe how we may come to terms with the acceleration of the world that we experience.

Of course, overly strict instructions for managing time may be counterproductive. They might wind up setting a course for everyday life that exerts too much pressure ("Now I just need to relax quickly and concentrate before I get the laundry"). A relaxed attitude toward life's demands does not begin from one day to the next. It might even turn out that a weekend retreat devoted to meditation, wellness, and gastronomy stands in the way of acquiring a different outlook on the rhythm of life. After all, the aim is to survive the reality of the everyday work environment. The learning process can succeed only in small steps: "learning by doing" in a relaxed manner.

We profit from the conveniences that more efficient and rapid cycles entail: a book can be picked up at the store mere hours after we order it; government

forms can be filled out online while seated comfortably on the sofa; doctors on call are only minutes away. These are the advantages that technological and organizational acceleration affords. At any rate, it surely is the case that we cannot simply withdraw from the social pace of life. If we “disconnect” from everyday routine and take a week’s vacation, 143 emails have piled up in the inbox when we return. We cannot change the speed of operations in our society. Nor can we change the number of new assignments the boss hands us. However, we can learn to deal with potential stressors. Negative stress reactions needn’t result. The point is to feel that we are in control of the demands we face. Technology and social patterns offer opportunities for us to shape our lives autonomously. At the same time, they pose the risk that we will simply be dragged along by the accelerated tempo and burn out. In many fields today, a professional skill that is implicitly required is subjective control of the accelerated speed of life and work. If we manage to stay in control, we can find time for other things—and for ourselves.

7 Body Time: How the Sense of Time Arises

If we put people in an isolation tank, the external senses—sight, hearing, smell—are rendered largely inoperative. Under these circumstances, only bodily presence persists. The flow of time, passing extremely slowly, is still experienced in this situation, suggesting that bodily processes underlie our feeling of time. Indeed, recent studies have confirmed that bodily functions—especially the heartbeat—are involved in the perception of temporal duration. The body functions as an internal clock for our sense of time.

If we think about it at any length, we have to admit that we cannot really perceive time. We do not have a sense of time in the same way that we have a sense of color, sound, and temperature. Perception, in the conventional understanding, involves a sensory quality: a color, a sound, a temperature. Certain sensory organs transmit those impressions. Our perception of time, on the other hand, is something special. To what, then, does the sense of time relate? The answer is not clear at all. There is also no independent sensory organ that would qualify as responsible for our perception of time.

One way to define the sense of time relates to the perception of change. We do not perceive time; rather, we experience change and movement.[1] Change tells us that time is passing. On the large scale of memory, autumn leaves indicate change, and looking in the mirror reveals changes that come with age over the years. On the smaller scale of seconds, music is rhythmically ordered change in sound. On the basis of changes in the world, registered by our senses, temporal relations emerge: event A comes before B. We perceive events as well as their temporal relations. But what happens when our senses do not register any signals from the environment, when no changes are perceived? Does time still exist?

In the 1950s, the American physician John C. Lilly became well known for his studies on the communicative behavior of dolphins. In subsequent decades, he achieved fame for his unconventional research on human consciousness, examining altered states of mind induced by meditative techniques and drugs.[2] Lilly also developed isolation tanks to bring about sensory deprivation; by this

means, subjects can achieve states similar to those produced by meditation. People spend an allotted span of time in a tank filled with water; as much as possible, external sensory stimuli are eliminated. Absolute darkness reigns. Almost nothing can be heard. The tank is soundproofed, and earplugs prevent the sounds of the water from reaching subjects. The water has a high salt content, and so one seems to float on one's back of one's own accord. The temperature of the water and air has been adjusted to body temperature, so that physical boundaries are noted less markedly. Even the slight pressure that would come from clothing has been eliminated. Floating without motion in the tank, one sees nothing, hears nothing, and smells nothing.

Many meditation techniques seek to control attention for "switching off" external stimuli in order to promote concentration on oneself. If nothing else, the tank makes it easy to eliminate external stimuli without years of practice. Still, wandering thoughts remain—indeed, they prove overwhelming under such extreme conditions of sensory deprivation. Even as one floats in the tank, cut off from external stimuli, changes occur. An extended stay in the tank leads to feelings of unease, a tingling sensation in the skin. Perception of one's body and space can change; ultimately, hallucinations may even occur. The brain, isolated from the world outside, constructs a world of its own. Even if most sensory activity is shut off temporarily, one sense in particular cannot be deactivated: body sense. Signals from the muscles and organs continue to flow to the brain without interruption. Physical presence has a certain consistency. Some bodily feelings recur periodically—for example, when one perceives one's breathing and heartbeat.

Under conditions of sensory deprivation, the sense of time does not disappear. However, when longer periods are involved, temporal orientation can certainly be impaired. Study participants who spent several hours in such a state later underestimated the time they had been in the tank drastically.[3] Because the situation contains no events—thus leaving fewer memories behind—subjects often thought that the time spent in the tank was much less than it really had been. However, while in the tank, they experienced time passing slowly (and often disagreeably so). The perception of time in the isolation tank is tied to changes in consciousness and bodily states. Time is experienced as passing especially slowly because there are no distractions; in contrast to the other senses, only the body sense is active.

Body Time—How the Sense of Time and Bodily Sensations Are Linked

The laboratory under the supervision of Martin Paulus at the University of California at San Diego (UCSD) conducts research on matters of complex decision making and emotion regulation in patients with drug addiction, anxiety disorders, and depression. Studies directed by Paulus, Alan Simmons, and Irina Strigo that use functional magnetic resonance imaging (fMRI) have revealed, time and again, the markedly elevated activation of the insular cortex in these psychiatric patient groups (on the structure and function of the insula, see chapter 6).

Since the insular cortex—along with other structures in the brain—is involved in the emotional assessment of events, overactivation measured in patients provides a neurobiological marker for the valuation system that has become imbalanced. Elevated activity of the anterior insular lobe can be demonstrated in patients with anxiety disorders or depression, especially when they anticipate an unpleasant situation that, subjectively, entails unease and anxiety.[4] The overactivation of the insular lobe and other brain structures involved in emotional reactions during anticipatory situations experienced as disagreeable recedes noticeably when antianxiety medicines are provided—neurobiological evidence for the drugs' efficacy.[5]

A. D. (Bud) Craig, of the Barrow Neurological Institute in Phoenix, works closely with the researchers at UCSD. Craig has played a decisive role in shaping the prevailing view of the neurobiological bases of bodily perception (see chapter 6). During my time at UCSD conducting experiments on the perception of time with fMRI methods, Craig was formulating a new theory of temporal perception based on his insights into the anatomy and function of the insular lobe.[6]

This provided the context for my research at UCSD. The task that was evaluated was as straightforward as possible. As they lay in the fMRI scanner, subjects were asked to estimate, as precisely as possible, the temporal duration of the tones they were given. The duration of tones alternated between three, nine, and eighteen seconds at random. At first, a tone of a certain duration was played (target stimulus). Then, after a short pause, a second tone was played

(comparison stimulus). Subjects were instructed to stop the comparison stimulus by pressing a key when the duration of the target stimulus had been reached. That is, tones of varying duration were played and reproduced in duration by the press of a key.[7]

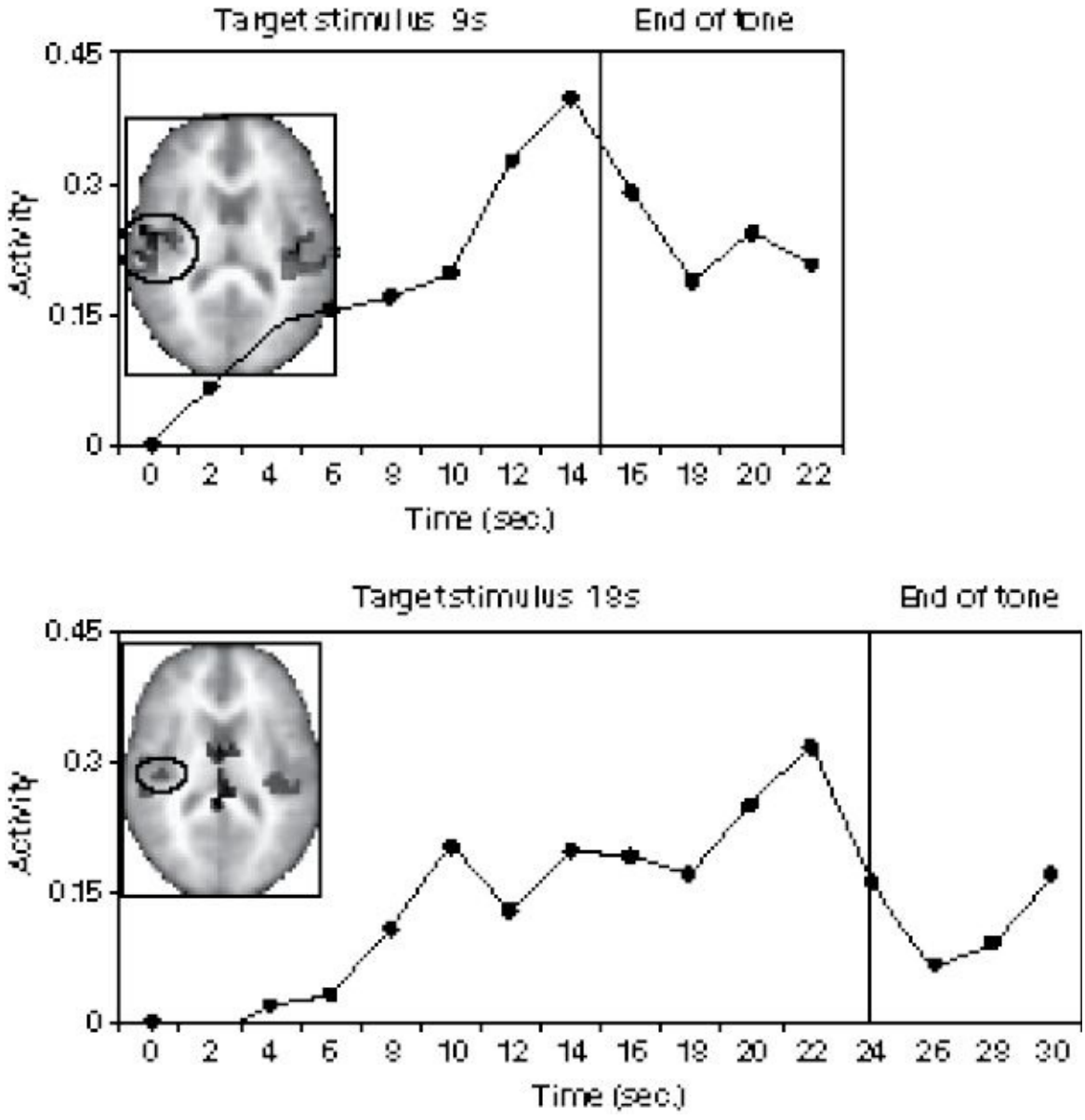


Figure 11

Regularly increasing activity in the right posterior insular cortex (circled on both images) for the durat of the target stimulus, peaking at the end of the tone (black vertical line). Because of inexact tempc resolution at approximately two seconds, activity seems to sink again shortly before the tone ends. Si maximal activity in response to external stimuli is demonstrable only after six seconds, this span must added to the duration of the stimulus; accordingly, at nine seconds, the end of the tone is indicated a fifteen seconds, and at eighteen seconds after twenty-four seconds.

The novel feature of this study was that the temporal intervals of nine and eighteen seconds had never been provided in a task of temporal perception measured in an fMRI. The unusually long duration of temporal intervals enabled a very particular focus, namely, the pattern of activity over time as tones of varying durations were presented. Given the technological restrictions of the fMRI method, which has a relatively crude capacity for temporal resolution, physiological activity can normally be analyzed only in two-second increments. Therefore, when durations lasted nine and eighteen seconds, there was enough time for the whole sequence to be viewed in two-second units (see figure 11).

The measurements made during the target stimulus hold particular interest inasmuch as the subjective feeling of duration (a representation) is built up during this time. Therefore, when looking for a kind of internal clock in the brain —which might be responsible for constructing subjective duration in the range of a few seconds—it is important to analyze the target interval. Indeed, we noted significant activity in the insular lobe—or, more precisely, in the posterior insular lobe. Averaging results from all subjects, we found that activity in the posterior insula climbed steadily as tone duration increased; it "broke off" only when the target stimulus ended. When the target lasted nine seconds, activity peaked at around nine seconds; when it lasted eighteen seconds, it peaked at around eighteen seconds (see figure 11).

When analyzing activation, established theories might lead one to expect the "usual suspects"—regions that have long been discussed as being tied to temporal perception: the cerebellum, the basal ganglia, and the right frontal lobe. However, when we calculated physiological activity, it emerged that the insular lobe displayed heightened—and especially linearly increasing—activation connected with temporal duration.[8]

Is this a matter of chance or necessity? At the very least, it represents a remarkable coincidence: during the time I spent working at a leading lab for research on the insular lobe, it emerged that the insular cortex itself plays a role in temporal perception. The same experimental arrangement at another research institute would have led to the same results of insular activation. By chance, however, the tests were conducted in the lab supervised by Martin Paulus. Therefore, as a matter of relative necessity, results were interpreted in light of the knowledge about the *insula* that had been gathered in this particular lab. Chance

did not come into play here.

The signals informing the brain of the physiological condition of the body arrive in the posterior insular lobe (see chapter 6), providing elements necessary for a conscious representation of the body. Accordingly, the hypothesis about temporal perception developed on the basis of the findings described here held that the physiological signals arriving over time were integrated to evaluate duration in the range of seconds. Counter to what some researchers assume, there is no autonomous clock in the brain responsible exclusively for temporal perception. The feeling of time requires that signals arriving in the brain without interruption be collected. How long did the tone last? In accordance with a certain quantity of signals arriving from the body. Why was one stimulus longer than the other? Because more bodily signals were collected. It follows that temporal perception is based on the perception and integration of physical processes.

As generally holds for brain research with a psychological orientation, no single experiment exists that would answer all questions. The handily formulated hypothesis requires further verification with other methods. An experiment conducted at the Institute of Medical Psychology at the Ludwig Maximilian University in Munich soon afterward offered direct evidence that bodily signals provide the basis for subjective time.

A quick parenthetical remark: the fMRI experiment described just now should of course be viewed in the context of other studies investigating temporal perception. Several meta-analyses of fMRI studies of time perception (that is, analyses of many dozens of studies) show that the insular lobe indeed was activated very often. That is the problem with the fMRI method: at any given time, multiple parts of the brain are almost always active. To oversimplify the matter, each researcher “cherry-picks” the regions that suit him or her. Many different brain regions are almost always active simultaneously; because of the researcher’s presuppositions, views find ready confirmation when the preferred brain region “lights up.” In the process, other parts of the brain that have also been activated receive no attention. However, a meta-analysis that soberly counts the different sites of activation reveals that the insular lobe—in conjunction with other regions—is typically involved in human time perception, as Bud Craig was first to note.[9]

Numerous studies directly measuring brain activity in mice, rats, pigeons, and

monkeys provide further evidence that steadily increasing brain activity may constitute an internal clock. When the animals learn to push a lever or disk after a fixed interval, a comparable increase in brain activity occurs, peaking at the moment the target movement is performed—as in the fMRI experiment with human beings. It could be that a mechanism exists in the brain: cerebral activity climbs until reaching a certain threshold value; then it peaks and a representation of temporal duration results.[10]

The first direct evidence for the connection between bodily processes and time estimates was provided by research directed by Karin Meissner at the Munich Institute of Medical Psychology.[11] With almost the same experimental design as the fMRI study described above, subjects were asked to reproduce tone durations. This time, participants in the study did not lie in the fMRI tube; instead, electrodes and sensors applied to the skin measured three important bodily functions: heartbeat, breathing frequency, and skin conductance. These three physical parameters make up a person's state of physiological agitation. In principle, the sympathetic nervous system activates organs, while the parasympathetic system calms them. Increased physical or mental excitation is distinguished by heightened sympathetic activity and diminished parasympathetic activity: heartbeat and breathing frequency become more pronounced, and skin conductance increases because the sweat glands are at work. Increased relaxation, on the other hand, is distinguished by increased parasympathetic activity and lessening sympathetic activity: heartbeat and respiration slow down, and skin conductance decreases.

In the context of Meissner's study, it emerged that for tones lasting for eight, fourteen, and twenty seconds, breathing rate and skin conductance diminished as the tone duration increased, reaching a minimum when it ended. The clearest connection to time perception was evident in the heart rate. A calming pattern emerged, which was evident in the slowing down of the heartbeat, and it persisted until the tone ended, where a minimum was reached. Moreover, we determined a statistical relation to the precision of temporal perception: the more markedly the heartbeat decreased, the less the individual underestimated the times, becoming more exact in reproducing the temporal duration.

The relation was taken to indicate that the integration of body signals over time, especially of parasympathetic signals of the heart, may underlie subjective representations of duration. The connection held not only between objective physiological parameters and subjects' capacity to assess temporal duration;

subjects' capacity to perceive their heart rate consciously also varied according to the precision displayed in the task of temporal reproduction. Subjects were asked to count their heartbeats in time spans lasting up to a minute. This test determined how sensitive people are to their heartbeats—how consciously they feel their own heart beating.[12] Later, when results were compared with the time-reproduction task, it was quite plain: subjects who were more accurate in counting their heartbeats could reproduce temporal intervals more accurately, too.

It follows that subjective time is the time of the body, the perception of change, and related to bodily processes. That is why the passing of time is experienced so intensely in an isolation tank. Even if external stimuli are largely deactivated, the inner body sense remains—which is also the temporal sense. Because I have a body, I perceive the passing of time. Physiological processes over time provide a temporal reference for processes in the external world.

A further consequence holds as well: subjective time passes at different rates, depending on the bodily state somewhere between relaxation and excitement. From this perspective, subjective time is "body time." Naturally, this does not mean that experiencing duration is equivalent to conscious awareness of physical functions. Six seconds are not experienced as a determinate quantity of heartbeats or other body processes. That would stand at odds with all experience. Physical processes simply provide the foundation; the conscious feeling of time emerges only after a whole series of other steps have occurred in the brain's processes (see chapter 6).

On Bodily Rhythm, Feeling, and Temporal Perception

The idea of "body time" is not new. However, brain researchers and psychologists who investigate temporal perception have scarcely looked at this idea seriously until now. Jean-Marie Guyau, a philosopher and poet in nineteenth-century France, articulated the concept in his treatise, *La génèse de l'idée du temps*.[13] According to his idea, the infant develops the idea of time as bodily needs arise. The child is hungry and so she cries. Expectation builds, and so does the feeling of time through the waiting period—the span of the feeling of hunger—that continues until the child is fed. Later, at the crawling stage, the child must physically exert herself to reach an object some distance away. Here,

too, expectation plays a role; according to Guyau, the concept of the future emerges as a result: temporal duration is experienced as the time one has to wait until a bodily need is satisfied and as how long one has to perform some physical activity.

Newborns already have a rudimentary sense of time. Thus, they can recognize that the frequency of their spontaneous sucking differs from the ticking of a metronome when it speeds up.[14] That is, infants perceive the temporal asynchrony between their own periodic movement and a recurring, external stimulus. In the womb, before being born, the fetus encounters several natural pacemakers, to which it grows accustomed: in a state of calm, the mother's heartbeats arrive at a rate a little faster than once a second; it takes about three seconds for the mother to breathe in and out. A newborn's heart also beats a little faster (about twice a second), which corresponds to the frequency of spontaneous sucking. Thus the infant perceives periodically recurring body signals and carries out rhythmic movements. Bodily processes such as heartbeat and respiration could therefore represent an inner rhythm by which we measure temporal patterns of the external world. It might not be surprising, in this context, to learn that the primary brain structure involved in recognizing the heartbeat is the right anterior insular lobe—as an fMRI study conducted by a team of English researchers working with Hugo Critchley has shown.[15] The more accurately subjects could feel their own heartbeat, the stronger the activity in the right anterior insular lobe.

The insular cortex also plays a decisive role in perceiving temporal patterns of external stimuli, that is, rhythm. Researchers in Tübingen had subjects in an fMRI hear sequences of click stimuli with varying tempos in a range between 2 and 6 Hz.[16] They determined that individual brain regions are sensitive to frequency: for example, activity in the cerebellum increased when click stimuli sped up. However, what became especially clear was that the left and right anterior insular cortex displayed inverse activation depending on frequency. The faster the speed, the more activity there was in the left insula; the slower the speed, the more activity in the right insula. Rhythm and tempo in music are fundamentally connected to movement (especially in dance), cardiac activity, respiration, and feelings. All these components—tempo, time, bodily feelings, and emotion—come together in functions performed by the insular cortex.

Temporal experience, self-consciousness, and the perception of bodily states

and feelings are tightly bound to each other; they cannot be experienced separately (see chapter 6). The Greek psychoanalyst Peter Hartocollis recognized as much and summed up his clinical experiences with psychiatric patients in the book, *Time and Timelessness*.[17] Disturbances of ego-identity and affects, he argues, occur noticeably in conjunction with impairments to temporal orientation, changes in temporal perspective, and difficulty assessing duration. Indeed, an array of empirical studies has demonstrated that patients suffering from depression and anxiety generally overestimate temporal durations.[18] In situations that trigger intense fear, time expands enormously: people with arachnophobia who had to view living spiders up close for forty-five seconds overestimated this interval more than people who had no particular fear of spiders.[19] Unusually stressful situations lead to subjective time dilations in all human beings; for example, in a group of people parachuting for the first time (in tandem), those who experienced more fear judged that the jump had lasted longer.[20]

Social psychologists came up with a devious experiment: members of a discussion group were told to introduce themselves to each other individually, so that they could later form groups of two.[21] Following the discussion, separate meetings were held, and half of the participants (chosen at random) were told that no one had expressed interest in them; this was intended to create a feeling of social exclusion. The other half were told that others were interested in working with them. The (seemingly) excluded were made to feel marked social undesirability, in contrast to those who had (seemingly) found acceptance; they reacted verbally by expressing intense feelings of negative self-worth, a sense of being dazed, even of being in shock. This condition led, in tests that were then conducted, to greater present-orientation and reduced readiness to wait (see chapter 1); in addition, subjects overestimated temporal intervals lasting for forty and eighty seconds. In other words, the sense of social isolation triggered a subjective expansion of time. This study demonstrates that it is not just rare and unusual situations that lead to changes in temporal perception. Relatively commonplace fluctuations in experience can produce the same effect.

That said, the feeling of temporal expansion can also occur when the body is in a state of rest—be it through meditation or in an isolation tank. In these particular situations of inner calm, when one concentrates on oneself and one’s corporeality, time passes more slowly and the duration becomes subjectively longer. On the one hand, intense physical excitement entails temporal expansion;

on the other hand, extreme relaxation also makes time seem to last longer. Is there a contradiction here? Only at first glance. In either case, a heightened perception of body processes occurs—both when the body is active and when there is relaxed focus on the bodily self. Many kinds of meditation refer explicitly to the bodily self ("Feel how your arm is lying on the floor"). Instructions like this lead one to concentrate on individual parts of one's body, to experience their warmth and weight. Or one might focus on one's breath and become aware of one's heartbeat. When we perceive the body and its processes in this way, time passes very slowly.[22] Bodily presence thus creates awareness of time.

Art and Body

The artist Marina Abramović put the experience of time and personal embodiment on display at the Museum of Modern Art (MoMA) in New York in 2010. For three months, she was a living installation, seated immobile and silent on a chair for seven and a half hours at a stretch.[23] Since she did not grant herself even the shortest break, she had to train intensively to be able to remain motionless during the performance. In addition, she had to find out what quantities of water to drink during her free time—and when—so that she would not have to use the restroom over the course of the day. In the exhibition *The Artist Is Present*, visitors could sit facing her and share her experience for a short while. This was a limit-experience for the body artist, offering no possibility for distraction or liberating motion. She was constantly at the center of attention for visitors. Her own body was the medium. Abramović was defenseless, at the mercy of her bodily perception—including whatever tensions or pains might arise. She was all body. In this, she was very close to the passing of time.

Notes

1 Temporal Shortsightedness: On Being Able to Wait

1. V. Dufour, C. A. F. Wascher, A. Braun, R. Miller, and T. Bugnyar, “Corvids Can Decide if a Future Exchange Is Worth Waiting For,” *Biology Letters* 8 (2012): 201–204.

2. W. Mischel, Y. Shoda, and P. K. Peake, “The Nature of Adolescent Competencies Predicted by Preschool Delay of Gratification,” *Journal of Personality and Social Psychology* 54 (1988): 687–696; Y. Shoda, W. Mischel, and P. K. Peake, “Predicting Adolescent Cognitive and Self-Regulatory Competencies from Preschool Delay of Gratification: Identifying Diagnostic Conditions,” *Developmental Psychology* 26 (1990): 978–986.

3. D. Goleman, *Emotional Intelligence: Why It Can Matter More Than IQ* (New York: Bantam, 1995).

4. G. J. Madden, A. M. Begotka, B. R. Raiff, and L. L. Kastern, “Delay Discounting of Real and Hypothetical Rewards,” *Experimental and Clinical Psychopharmacology* 11 (2003): 139–145; M. Wittmann, K. L. Lovero, S. D. Lane, and M. P. Paulus, “Now or Later? Striatum and Insula Activation to Immediate versus Delayed Rewards,” *Journal of Neuroscience, Psychology, and Economics* 3 (2010): 15–26.

5. G. Ainslie, “Specious Reward: Behavioral Theory of Impulsiveness and Impulse Control,” *Psychological Bulletin* 82 (1975): 463–496; M. Wittmann and M. P. Paulus, “Decision Making, Impulsivity, and Time Perception,” *Trends in Cognitive Sciences* 12 (2008): 7–12.

6. M. Wittmann and M. P. Paulus, “Temporal Horizons in Decision Making,” *Journal of Neuroscience, Psychology, and Economics* 2 (2009): 1–11.

7. T. Roenneberg and J. Aschoff, “Annual Rhythm of Human Reproduction: II. Environmental Correlations,” *Journal of Biological Rhythms* 5 (1990): 217–239; A. Wirz-Justice, K. Kräuchi, and P. Graw, “An Underlying Circannual Rhythm in Seasonal Affective Disorder?” *Chronobiology International* 18 (2001): 309–313.

8. The cyclical pattern of events on Earth depending on astronomy—the sun’s revolution over twenty-four hours, phases of the moon, the seasons—are, from the religious or spiritual perspective of many archaic cultures, an indication that death is connected to life, and that a new beginning follows death. In Christianity, the church year commemorates, cyclically and ritually, the birth and death of Christ. The year also represents a fixed duration of time in a spiritual sense for all cultures; see Mircea Eliade, *The Sacred and the Profane: The Nature of Religion*, trans. Willard Trask (New York: Harcourt Brace Jovanovich, 1987).

9. A recent linguistic study has shown that the temporal horizons of a day and a year emerge with the highest frequency in spontaneous linguistic performance in Polish speakers: J. T. Waliński, “Reflection of Temporal Horizon in Linguistic Performance,” *Procedia—Social and Behavioral Sciences* 126 (2014): 178–187.

10. Y. Trope and N. Liberman, “Construal-Level Theory of Psychological Distance,” *Psychological Review* 117 (2010): 440–463; S. A. Malkoc, G. Zauberman, and C. Ulu, “Consuming Now or Later? The Interactive Effect of Timing and Attribute Alignability,” *Psychological Science* 16 (2005): 411–417.

11. P. G. Zimbardo and J. N. Boyd, “Putting Time in Perspective: A Valid, Reliable Individual Differences Metric,” *Journal of Personality and Social Psychology* 77 (1999): 1271–1288.

12. K. Rubia, R. Halari, A. Christakou, and E. Taylor, “Impulsiveness as a Timing Disturbance: Neurocognitive Abnormalities in Attention-Deficit Hyperactivity Disorder during Temporal Processes and Normalization with Methylphenidate,” *Philosophical Transactions of the Royal Society B* 364 (2009): 1919–1931.

13. H. A. Berlin, E. T. Rolls, and U. Kischka, “Impulsivity, Time Perception, Emotion, and Reinforcement Sensitivity in Patients with Orbitofrontal Cortex Lesions,” *Brain* 127 (2004): 1108–1126; M. Wittmann, D. Leland, J. Churan, and M. P. Paulus, “Impaired Time Perception and Motor Timing in Stimulant-Dependent Subjects,” *Drug and Alcohol Dependence* 90 (2007): 183–192.

14. The frontal lobe of the cerebral cortex plays a key role in impulse control. Studies that use imaging techniques reveal increased activity in these regions when subjects suppress the impulse to act. The comparatively late development of the frontal lobe accounts for the more pronounced impulsivity of children and teenagers; this process is only complete in early adulthood.

15. This has been demonstrated by studies conducted by Sylvie Droit-Volet at Université Blaise Pascal in Clermont-Ferrand: S. Droit-Volet, “Child and Time,” in *Multidisciplinary Aspects of Time and Time Perception*, ed. A. Vatakis et al., 2010 Lecture Notes in Computer Science 6789 (Berlin: Springer, 2011), 151–172.

16. R. Kivetz and A. Keinan, “Repenting Hyperopia: An Analysis of Self-Control Regrets,” *Journal of Consumer Research* 33 (2006): 273–282.

17. Philip Zimbardo shared this personal anecdote during his presentation at the forty-third annual meeting of the German Society for Psychology (Berlin, 2002).

18. Philip Zimbardo and John Boyd, *The Time Paradox: The New Psychology of Time That Will Change Your Life* (New York: Simon & Schuster, 2009).

19. J. Metcalfe and W. Mischel, “A Hot/Cool System Analysis of Delay of Gratification: Dynamics of Willpower,” *Psychological Review* 106 (1999): 3–19.

20. S. McClure, D. Laibson, G. Loewenstein, and J. Cohen, “Separate Neural Systems Value Immediate and Delayed Monetary Rewards,” *Science* 306 (2004): 503–507.

21. B. J. Casey, L. H. Somerville, I. H. Gotlib, O. Ayduk, N. T. Franklin, M. K. Askren, J. Jonides, M. G. Berman, N. L. Wilson, T. Teslovich, G. Glover, V. Zayas, W. Mischel, and Y. Shoda, “Behavioral and Neural Correlates of Delay of Gratification 40 Years Later,” *Proceedings of the National Academy of Science* 108 (2011): 14998–15003.

22. Anthony Damasio, *Descartes’ Error: Emotion, Reason, and the Human Brain* (New York: Penguin, 2005).

2 Looking for the Rhythm of the Brain

1. I. J. Hirsh and C. E. Sherrick, “Perceived Order in Different Sense Modalities,” *Journal of Experimental Psychology* 61 (1961): 423–432; M. Fink, P. Ulbrich, J. Churan, and M. Wittmann, “Stimulus-Dependent

Processing of Temporal Order," *Behavioral Processes* 71 (2006): 344–352.

2. P. Ulbrich, J. Churan, M. Fink, and M. Wittmann, "Perception of Temporal Order: The Effects of Age, Sex, and Cognitive Factors," *Aging, Neuropsychology, and Cognition* 16 (2009): 183–202.

3. A. Szymaszek, M. Sereda, E. Pöppel, and E. Szelag, "Individual Differences in the Perception of Temporal Order: The Effect of Age and Cognition," *Cognitive Neuropsychology* 26 (2009): 135–147.

4. M. Amelung and R. Steinmayr, "Is There a Validity Increment for Tests of Emotional Intelligence in Explaining the Variance of Performance Criteria?" *Intelligence* 34 (2006): 459–468.

5. E. Pöppel, *Mindworks: Time and Conscious Experience* (Boston: Harcourt Brace Jovanovich, 1988).

6. E. Pöppel, "Excitability Cycles in Central Intermittency," *Psychological Research* 34 (1970): 1–9; S. Dehaene, "Temporal Oscillations in Human Perception," *Psychological Science* 4 (1993): 264–270. For a different analytical approach to assessing the discreteness of underlying processes in motor timing, see B. Burle and M. Bonnet, "What's an Internal Clock For? From Temporal Information Processing to Temporal Processing of Information," *Behavioural Processes* 45 (1999): 59–72.

7. U. Ribary, S. M. Doesburg, and L. M. Ward, "Thalamocortical Network Dynamics: A Framework for Typical/Atypical Cortical Oscillations and Connectivity," in *Magnetoencephalography*, ed. S. Supek and C. Aine (Berlin: Springer, 2014), 429–449; C. Başar-Eroglu, D. Strüber, M. Schürmann, M. Stadler, and E. Başar, "Gamma-Band Responses in the Brain: A Short Review of Psychophysiological Correlates and Functional Significance," *International Journal of Psychophysiology* 24 (1996): 101–112; E. Pöppel, "A Hierarchical Model of Temporal Perception," *Trends in Cognitive Sciences* 1 (1997): 56–61; W. Singer and C. M. Gray, "Visual Feature Integration and the Temporal Correlation Hypothesis," *Annual Review of Neuroscience* 18 (1995): 555–586.

8. R. Van Rullen and C. Koch, "Is Perception Discrete or Continuous?" *Trends in Cognitive Sciences* 7 (2003): 207–213; A. A. Fingelkurts and A. A. Fingelkurts, "Timing in Cognition and EEG Brain Dynamics: Discreteness versus Continuity," *Cognitive Processing* 7 (2006): 135–162; M. A. Elliott, Z. Shi, and S. D. Kelly, "A Moment to Reflect upon Perceptual Synchrony," *Journal of Cognitive Neuroscience* 18 (2006): 1663–1665. However, predictions of cognitive models pertaining to the discreteness of perception, i.e., perception of temporal order, do not necessarily correspond to the outcomes of empirical tests. For these problems, see R. Ulrich, "Threshold Models of Temporal-Order Judgments Evaluated by a Ternary Response Task," *Perception & Psychophysics* 42 (1987): 224–239.

9. R. Llinás, U. Ribary, D. Contreras, and C. Pedroarena, "The Neural Basis for Consciousness," *Philosophical Transactions of the Royal Society B* 353 (1998): 1841–1849; A. Schurger, A. Cowey, and C. Tallon-Baudry, "Induced Gamma-Band Oscillations Correlate with Awareness in Hemianopic Patient GY," *Neuropsychologia* 44 (2006): 1796–1803.

10. The original idea of the perceptual moment was formulated by J. M. Stroud, "The Fine Structure of Psychological Time," in *Information Theory in Psychology*, ed. H. Quastler (Glencoe, IL: Free Press, 1955); empirical evidence for discrete processing around 10 Hz can be found in N. A. Busch, J. Dubois, and R. VanRullen, "The Phase of Ongoing EEG Oscillations Predicts Visual Perception," *Journal of Neuroscience* 29 (2009): 7869–7876.

11. V. van Wassenhove, "Minding Time in an Amodal Representational Space," *Philosophical Transactions of the Royal Society B: Biological Sciences* 364 (2009): 1815–1830; M. Wittmann, "Moments in Time," *Frontiers in Integrative Neuroscience* 5, no. 66 (2011); D. Poeppel, "The Analysis of Speech in Different Temporal Integration Windows: Cerebral Lateralization as 'Asymmetric Sampling in Time,'" *Speech Communication* 41 (2003): 245–255.

12. W. B. Scoville and B. Milner, "Loss of Recent Memory after Bilateral Hippocampal Lesions," *Journal of Neurology, Neurosurgery, and Psychiatry* 20 (1957): 11–21. "The Lost Mariner," a clinical case presented

by Oliver Sacks, affords insight into the world of a patient trapped in his short-term memory. The patient in question suffers from Korsakoff's syndrome, the alcohol-induced degeneration of the neural system involved in memory storage: Oliver Sacks, *The Man Who Mistook His Wife for a Hat: And Other Clinical Tales* (New York: Touchstone, 1998).

13. L. Swisher and I. Hirsh, "Brain Damage and the Ordering of Two Temporally Successive Stimuli," *Neuropsychologia* (1972) 10: 137–152; M. Wittmann, A. Burtscher, W. Fries, and N. von Steinbüchel, "Effects of Lesion Size and Location on Temporal-Order Judgment in Brain-Injured Patients," *Neuroreport* 15 (2004): 2401–2405.

14. M. Fink, J. Churan, and M. Wittmann, "Temporal Processing and Context Dependency of Phoneme Discrimination in Patients with Aphasia," *Brain and Language* 98 (2006): 1–11; R. Efron, "Temporal Perception, Aphasia, and Dèjà Vu," *Brain* 86 (1963): 403–424.

15. P. Tallal, S. Miller, and R. H. Fitch, "Neurobiological Basis of Speech: A Case for the Preeminence of Temporal Processing," *Annals of the New York Academy of Sciences* 682 (1993): 27–47; but see a discussion of critical issues pertaining to the alleged association between language and time: M. Wittmann and M. Fink, "Time and Language: Critical Remarks on Diagnosis and Training Methods of Temporal-Order Judgement," *Acta Neurobiologiae Experimentalis* 64 (2004): 341–348.

16. The dissertation submitted by Nicole von Steinbüchel to the Institute for Medical Psychology at the Ludwig Maximilian University of Munich in 1985 contained the first demonstration of trained order thresholds in patients with aphasia. For discussion, see N. von Steinbüchel and E. Pöppel, "Domains of Rehabilitation: A Theoretical Perspective," *Behavioral Brain Research* 56 (1993): 1–10. Successful training of order thresholds in children with speech development disorders was first reported in 1996: M. Merzenich, W. Jenkins, P. Johnston, C. Schreiner, S. Miller, and P. Tallal, "Temporal Processing Deficits of Language-Learning Impaired Children Ameliorated by Training," *Science* 271 (1996): 77–81.

17. L. Swisher and I. Hirsh, "Brain Damage and the Ordering of Two Temporally Successive Stimuli," *Neuropsychologia* (1972) 10: 137–152.

18. F. Binkofski and R. A. Block, "Accelerated Time Experience after Left Frontal Cortex Lesion," *Neurocase* 2 (1996): 485–493.

19. O. Pötzl, "Weiteres über das Zeitraffer-Erlebnis," *Wiener Zeitschrift für Nervenheilkunde und deren Grenzgebiete* 4 (1951): 9–39.

20. A clear account of this kind of experience is provided by John C. Eccles, the neurophysiologist and Nobel laureate, in K. Popper and J. C. Eccles, *The Self and Its Brain: An Argument for Interactionism* (London: Routledge, 1986), 529.

21. V. Arstila, "Time Slows Down during Accidents," *Frontiers in Psychology*, 3 (2012): 196; M. Wittmann, "The Subjective Flow of Time," in *The Encyclopedia of Time*, ed. H. J. Birks (Thousand Oaks, CA: Sage, 2009), 1322–1324.

22. C. Stetson, M. P. Fiesta, and D. M. Eagleman, "Does Time Really Slow Down during a Frightening Event?" *PLoS ONE* 2 (2007): e1295.

23. This capacity for temporal resolution does not depend only on peripheral mechanisms, e.g., the sensory cells of the retina; rather, it can also be modulated by "higher" cognitive operations involving the ability to maintain attention. Hans Strasburger and Dorothe Poggel, at the Generation Research Program (Bad Tölz), have measured the capacity for temporal resolution in people at almost every stage of adulthood by means of double-pulse perimetry. The results indicate that this capacity relies not only on sensory cells in the eye but also on central functions in the brain: D. A. Poggel, B. Treutwein, C. Calmanti, and H. Strasburger, "Increasing the Temporal G(r)ain: Double Pulse Resolution Is Affected by the Size of the Attention Focus," *Vision Research* 46 (2006): 2998–3008. Moreover, an effect of aging was determined: older people display

increasingly large temporal thresholds, that is, their capacity for temporal resolution decreases progressively.

24. V. van Wassenhove, M. Wittmann, A. D. Craig, and M. P. Paulus, “Psychological and Neural Mechanisms of Subjective Time Dilation,” *Frontiers in Neuroscience* 5, no. 56 (2011).

25. S. Droit-Volet and S. Gil, “The Time–Emotion Paradox,” *Philosophical Transactions of the Royal Society B* (2009): 1943–1954; B. K. Kim, G. Zauberman, “Can Victoria’s Secret Change the Future? A Subjective Time Perception Account of Sexual-Cue Effects on Impatience,” *Journal of Experimental Psychology: General* 142 (2013): 328–335.

3 In the Moment: Three Seconds of Presence

1. Steven Pinker, *The Better Angels of Our Nature: Why Violence Has Declined* (New York: Penguin, 2012).

2. This claim touches on a highly complex subject; naturally, it calls for critical discussion. Even if some of its aspects should prove untenable, the effort—undertaken by a psychologist oriented in natural science—deserves recognition for refusing to offer yet another account of human evolution that is apocalyptic or, alternately, based on a simplistic idea of ultimate salvation. What is more, Pinker’s book demonstrates how porous boundaries between fields actually are. To explore arguments on this scale, scholars in the humanities, social sciences, and natural scientists would have to work together. The reasons for the social transformation in question would have to be approached in a transdisciplinary fashion: a hundred years ago, the average Central European male was nationalistic, racist, anti-Semitic, sexist, and homophobic. Or, consider the television series *Mad Men*, which takes place in the 1960s at an advertising agency in New York. In the social framework of the times, it is a matter of course that women, Jews, blacks, and homosexuals are discriminated against. Today, openly gay men are mayors in Paris and Berlin, and an African American is president of the United States (after prevailing against female candidates in the two main parties). Why have the attitudes of so many people changed? For a strictly opposing view, see J. Gray, *The Soul of the Marionette: A Short Inquiry into Human Freedom* (London: Allen Lane, 2015), who claims that there is no real moral progress.

3. Elisabeth Kübler-Ross was the first to record, systematically, how human beings confront the prospect of death and the phases of dying: E. Kübler-Ross, *On Death and Dying* (New York: Simon & Schuster, 2011).

4. Jon Kabat-Zinn has written many books on mindfulness meditation, which is more than just a method of psychological treatment for patients. Doctors and care providers at some clinics also learn this meditation technique in order to attend to patients with fuller concentration—and manage stressful professional situations, too. After all, everyone stands to gain from emotional stability and mental vigor in everyday routines. It is a matter of resilience—the psychic capacity for withstanding stressors in life.

5. P. Grossman, L. Niemann, S. Schmidt, and H. Walach, “Mindfulness-Based Stress Reduction and Health Benefits: A Meta-Analysis,” *Journal of Psychosomatic Research* 57 (2004): 35–43.

6. B. K. Hölzel, S. W. Lazar, T. Gard, Z. Schuman-Olivier, D. R. Vago, and U. Ott, “How Does Mindfulness Meditation Work? Proposing Mechanisms of Action from a Conceptual and Neural Perspective,” *Perspectives on Psychological Science* 6 (2011): 537–559; H. Walach and S. Schmidt (eds.), *Meditation—Neuroscientific Approaches and Philosophical Implications* (Cham: Springer, 2014).

7. Philosophers have posed the question of how long the present moment actually lasts. However, some of them object that the temporal moment has no extension. In physics, “moment” refers to a mathematical

point without extension in the temporal continuum. If an instant we experience as momentary were to possess temporal extension, one would be able to define a point within this hypothetical span; "in front of" and "behind" it would be two other points (the past and the future). Accordingly, such an extension could not represent a moment, for it would include all three dimensions of time all over again. So does the moment have no extension, after all? In this context, philosophers speak of the enigma of consciousness: how is it possible for us to experience motion, change, and the passing of time if perception occurs in a moment, or for an instant, which by definition lacks extension? One idea of how this is possible comes from the technology of the cinema. If something like snapshots of discrete moments really did exist, they could occur in succession, as in a film, and ensure the temporal dynamism of our experience. But perhaps these questions—and the solutions proposed for them—are merely theoretical. Might it be that language—the linguistic definition of the present moment borrowed from mathematics and physics—leads us to define problems that do in fact not exist?

8. K. Flasch, *Was ist Zeit? Augustinus von Hippo: Das XI. Buch der Confessiones* (Frankfurt am Main: Vittorio Klostermann, 1993), 259. Augustine, *Confessions*, trans. Henry Chadwick (Oxford: Oxford University Press, 2009), 235.

9. B. Dainton, "Seeing Change," *Philosophical Issues* 18 (2008): 362–384; C. Hoerl, "Time and Tense in Perceptual Experience," *Philosopher's Imprint* 9 (2009): 1–18; J. Kiverstein, "Making Sense of Phenomenal Unity: An Intentionalist Account of Temporal Experience," *Royal Institute of Philosophy* suppl. 85 (2010): 155–181; M. Wittmann, "Moments in Time," *Frontiers in Integrative Neuroscience* 5 (2011): 66.

10. The example is taken from the book by Dan Lloyd, *Radiant Cool: A Novel Theory of Consciousness* (Cambridge, MA: MIT Press, 2004). A concept of present experience along phenomenological lines was developed by Edmund Husserl (1859–1938), who postulated three components: retention (what has just passed), impression (what is perceived right now), and protention (what is anticipated immediately). Augustine of Hippo elaborated the idea earlier in similar terms.

11. E. Pöppel, "The Measurement of Music and the Cerebral Clock: A New Theory," *Leonardo* 22 (1988): 83–89; F. Turner and E. Pöppel, "Metered Poetry, the Brain, and Time," in *Beauty and the Brain: Biological Aspects of Aesthetics*, ed. I. Rentschler, B. Herzberger, and D. Epstein (Basel: Birkhäuser, 1988), 71–90. The verse forms of hexameter, pentameter, and alexandrine—even though they exceed the three-second limit on the scale of the line—are marked by caesuras, which divide recitations into units of "now."

12. M. Wittmann and E. Pöppel, "Temporal Mechanisms of the Brain as Fundamentals of Communication —with Special Reference to Music Perception and Performance," *Musicae Scientiae*, special issue 1999–2000 (1999): 13–28.

13. E. Pöppel, *Mindworks: Time and Conscious Experience* (Boston: Harcourt Brace Jovanovich, 1988); E. Pöppel, "Pre-semantically Defined Temporal Windows for Cognitive Processing," *Philosophical Transactions of the Royal Society B* 364 (2009): 1887–1896. See also Francisco Varela's complementary idea of three temporal integration levels: F. J. Varela, "Present-Time Consciousness," *Journal of Consciousness Studies* 6 (1999): 111–140.

14. For recent empirical evidence, see S. L. Fairhall, A. Albi, and D. Melcher, "Temporal Integration Windows for Naturalistic Visual Sequences," *PloS One* 9 (2014): e102248. A comprehensive overview of the three-second present moment can be found in L. Spinney, "Once Upon a Time," *New Scientist* 225 (2015): 28–31; a seminal study on the integration window in sensorimotor processing is J. Mates, U. Müller, T. Radil, and E. Pöppel, "Temporal Integration in Sensorimotor Synchronization," *Journal of Cognitive Neuroscience* 6 (1994): 332–340. A variety of motor tasks and three-second integration processes are revealed in J. D. McAuley, M. R. Jones, S. Holub, H. M. Johnston, and N. S. Miller, "The Time of Our Lives: Life Span Development of Timing and Event Tracking," *Journal of Experimental Psychology: General* 135 (2006): 348–367.

15. A discussion of temporal segmentation and reversible figures is found in J. Wernery, H. Atmanspacher, J. Kornmeier, V. Candia, G. Folkers, and M. Wittmann, "Temporal Processing in Bistable Perception of the Necker Cube," *Perception* 44 (2015): 157–168. See also C. Gómez, E. D. Argandoa, R. G. Solier, J. C. Angulo, and M. Vázquez, "Timing and Competition in Networks Representing Ambiguous Figures," *Brain and Cognition* 29 (1995): 103–114; N. von Steinbüchel, M. Wittmann, and E. Szelag, "Temporal Constraints of Perceiving, Generating, and Integrating Information: Clinical Indications," *Restorative Neurology and Neuroscience* 14 (1999): 167–182.

16. S. N. Malloch, "Mothers and Infants and Communicative Musicality," *Musicae Scientiae* special issue 1999–2000 (1999): 29–57.

17. W. Tschacher, F. Ramseyer, and C. Bergomi, "The Subjective Present and Its Modulation in Clinical Contexts," *Timing and Time Perception* 1 (2013): 239–259.

18. C. Montemayor and M. Wittmann, "The Varieties of Presence: Hierarchical Levels of Temporal Integration," *Timing and Time Perception* 2 (2014): 325–338.

19. P. Goldman-Rakic, "Space and Time in the Mental Universe," *Nature* 386 (1997): 559–560.

20. F. J. Varela, "Present-Time Consciousness," *Journal of Consciousness Studies* 6 (1999): 111–140; S. Gallagher, "Philosophical Conceptions of the Self: Implications for Cognitive Science," *Trends in Cognitive Sciences* 4 (2000): 14–21.

21. Here I've bracketed the philosophically inspired notion of the impossibility of living in the present moment. The idea is as follows: whenever we try to concentrate on a moment, it has already passed. At the very instant when we consciously observe a moment, we are no longer in it. Our perception, which relies on awareness and attention, always occurs too late for us to be present.

22. Fyodor Dostoevsky, *The Idiot*, trans. Richard Pevear and Larissa Volokhonsky (New York: Vintage, 2003), 61; translation slightly modified.

23. H. U. Gumbrecht, *Our Broad Present: Time and Contemporary Culture* (New York: Columbia University Press, 2014).

24. My thanks to Harald Walach, who drew my attention to this quotation in his lecture, "Rezeptivität und Streben—die mystische Epistemologie Hugo de Balmas" (Kolloquium des Institutes für Grenzgebiete der Psychologie und Psychohygiene e. V., Freiburg, 2011); cf. Harald Walach, *Notitia experimentalis Dei —Experiential Knowledge of God: Hugh of Balma's Mystical Epistemology of Inner Experience—A Hermeneutic Reconstruction* (Salzburg: Analecta Cartusiana, 2010).

4 Internal Clocks: What We "Need" Time For

1. "Drivers inconvenienced by a road-widening project subjected construction workers to so much abuse—including death threats, gun shootings, a flying burrito—that the state shut down the highway. Last September, Charles Fenn was arrested and charged with assault with a deadly weapon on allegations that he clipped a flagman with his vehicle on his way home. Earlier this year, another worker felt a stinging sensation on the back of her leg. When she looked down, she found a BB pellet on the ground. 'If you have taken time out of someone's day and add more time to it, their patience levels go off the Richter scale,' said Terri Kasinga, a spokeswoman for the state transportation department." (July 20, 2007, 2:03 p.m. US/Eastern Time, Greg Risling, Associated Press).

2. T. Takahashi, T. Hadzibeganovic, S. Cannas, T. Makino, H. Fukui, and S. Kitayama, "On Cultural Neuroeconomics of Intertemporal Choice," *Neuroendocrinology Letters* 30 (2009): 185–191.

3. R. Levine, *A Geography of Time: The Temporal Misadventures of a Social Psychologist* (New York: Basic, 1998).

4. Within the United States, for example, there are differences between the East Coast and West Coast, even though both regions are among the richest in the world. New York is notorious for its fast-paced life; California, by contrast, is laid back, relaxed, and casual. "Cool" California also deals with time in a way that differs from the German standard. More than once, I rushed to the all-important lab meeting—the weekly gathering of some twenty researchers working under Martin Paulus at UCSD—only to find that no one had arrived yet. Then, in the course of the next ten or fifteen minutes, people would slowly trickle in.

5. M. Csikszentmihalyi, *Flow: The Psychology of Optimal Experience* (New York: Harper, 2008).

6. C. R. Gallistel and J. Gibbon, "Time, Rate, and Conditioning," *Psychological Review* 107 (2000): 289–344.

7. A. Mita, H. Mushiake, K. Shima, Y. Matsuzaka, and J. Tanji, "Interval Time Coding by Neurons in the Presupplementary and Supplementary Motor Areas," *Nature Neuroscience* 12 (2009): 502–507.

8. P. Pütz, P. Ulbrich, J. Churan, M. Fink, and M. Wittmann, "Duration Discrimination in the Context of Age, Sex, and Cognition," *Journal of Cognitive Psychology* 24 (2012): 893–900; P. Ulbrich, J. Churan, M. Fink, and M. Wittmann, "Temporal Reproduction: Further Evidence for Two Processes," *Acta Psychologica* 125 (2007): 51–65.

9. M. Treisman, "Temporal Discrimination and the Indifference Interval: Implications for a Model of the 'Internal Clock,'" *Psychological Monographs* 77 (1963): 1–31. In April 2014, more than fifty years after his article was published, Michel Treisman presented his model at the "TIMELY International Conference on Timing and Time Perception" in Corfu, Greece, and discussed it with researchers in attendance.

10. D. Zakay and R. A. Block, "Temporal Cognition," *Current Directions in Psychological Science* 6 (1997): 12–16.

11. For an overview of the numerous psychological and neurological models, see the special issue of the British journal *Philosophical Transactions of the Royal Society B* from 2009 (ed. M. Wittmann and V. van Wassenhove), which offers a collection of essays by leading researchers in the field.

12. J. Wackermann and W. Ehm, "The Dual Klepsydra Model of Internal Time Representation and Time Reproduction," *Journal of Theoretical Biology* 239 (2006): 482–493; J. E. R. Staddon, "Interval Timing: Memory, not a Clock," *Trends in Cognitive Science* 9 (2005): 312–314.

13. G. Marchetti, "Studies on Time: A Proposal on How to Get Out of Circularity," *Cognitive Processes* 10 (2009): 7–40; D. Eagleman and V. Pariyadath, "Is Subjective Duration a Signature for Coding Efficiency?" *Philosophical Transactions of the Royal Society B* 364 (2009): 1841–1852.

14. H. Hoagland, "The Physiological Control of Judgments of Duration: Evidence for a Chemical Clock," *Journal of General Psychology* 9 (1933): 267–287.

15. For an overview of scientific studies that have demonstrated that human beings can readily measure temporal durations of up to two to three seconds, see J. Gibbon, C. Malapani, C. L. Dale, and C. R. Gallistel, "Toward a Neurobiology of Temporal Cognition: Advances and Challenges," *Current Opinion in Neurobiology* 7 (1997): 170–184; E. Pöppel, "Pre-semantically Defined Temporal Windows for Cognitive Processing," *Philosophical Transactions of the Royal Society B* 364 (2009): 1887–1896. Earlier studies on the subject are also found in Fraisse; see note 16, below.

16. P. Fraisse, "Perception and Estimation of Time," *Annual Review of Psychology* 35 (1984): 1–37.

17. M. Donald, *A Mind So Rare: The Evolution of Human Consciousness* (New York: W. W. Norton, 2001).

18. T. Roenneberg, *Internal Time: Chronotypes, Social Jet Lag, and Why You're So Tired* (Cambridge, MA:

Harvard University Press, 2012).

19. J. Aschoff and R. Wever, “Spontanperiodik des Menschen bei Ausschluß aller Zeitgeber,” *Die Naturwissenschaften* 49 (1962): 337–342; J. Aschoff, “Circadian Rhythms in Man,” *Science* 148 (1965): 1427–1432.

20. J. Aschoff, “Human Perception of Short and Long Time Intervals: Its Correlation with Body Temperature and the Duration of Wake Time,” *Journal of Biological Rhythms* 13 (1998): 437–442.

21. T. Roenneberg and M. Merrow, “Circadian Clocks—the Fall and Rise of Physiology,” *Nature Reviews Molecular Cell Biology* 6 (2005): 965–971.

22. How does one determine the chronotype to which an individual belongs? Extreme chronotypes pose no difficulty: their alertness, or tiredness, in the morning and at night makes matters plain. (That said, one should bear in mind that most people, in accordance with the Gaussian distribution, occupy a position between the two extremes.) Other forms of behavior are also clear indicators: early risers eat a large breakfast on workdays, too, whereas late risers often have difficulty swallowing anything besides coffee in the morning. Chronotypes can be determined more precisely on the basis of when people go to sleep and wake up. When do you go to bed and get up on holidays—when no plans have been made and no alarm has been set? The midpoint between these two times can serve as a reference for determining an individual’s chronotype. For a person who goes to sleep at midnight and wakes up at 8:00 a.m., the midpoint of sleep occurs at 4:00 a.m., as a matter of course. People who display this value occupy the middle range of chronotypes. Anyone wishing to determine his or her chronotype can go online and fill out the English Munich Chronotype Questionnaire (MCTQ) developed by Till Roenneberg: https://www.bioinfo.mpg.de/mctq/core_work_life/core/introduction.jsp?language=eng.

23. M. Wittmann, J. Dinich, M. Merrow, and T. Roenneberg, “Social Jetlag: Misalignment of Biological and Social Time,” *Chronobiology International* 23 (2006): 497–509. Social jetlag is discussed at length in Till Roenneberg’s popular science book (see note 18, above).

24. T. Roenneberg, T. Kuehnle, P. P. Pramstaller, J. Ricken, M. Havel, A. Guth, and M. Merrow, “A Marker for the End of Adolescence,” *Current Biology* 14 (2004): R1038–R1039.

25. K. Wahistrom, “Changing Times: Findings from the First Longitudinal Study of Later High School Start Times,” *NASSP Bulletin* 84 (2002): 3–21.

5 Life, Happiness, and the Ultimate Time Limit

1. M. Wittmann and S. Lehnhoff, “Age Effects in the Perception of Time,” *Psychological Reports* 97 (2005): 921–935; W. J. Friedman and S. M. J. Janssen, “Aging and the Speed of Time,” *Acta Psychologica* 134 (2010): 130–141. A recent study has shown that in Japan people similarly report that the last ten years pass increasingly fast with age: S. M. Janssen, M. Naka, and W. J. Friedman, “Why Does Life Appear to Speed Up as People Get Older?” *Time and Society* 22 (2013): 274–290. That is, starting with our original study in 2005 (Wittmann and Lehnhoff), the results pointing to the ten-year span as sensitive to age differences have been reproduced in several industrialized nations.

2. D. Zakay and R. A. Block, “Temporal Cognition,” *Current Directions in Psychological Science* 6 (1997): 12–16; N. Bailey and C. S. Areni, “Background Music as a Quasi Clock in Retrospective Duration Judgments,” *Perceptual and Motor Skills* 102 (2006): 435–444.

3. D. Avni-Babad and I. Ritov, “Routine and the Perception of Time,” *Journal of Experimental Psychology: General* 132 (2003): 543–550.

4. E. Pöppel, *Mindworks: Time and Conscious Experience* (Boston: Harcourt Brace Jovanovich, 1988).

5. U. Staudinger, A. Freund, M. Linden, and I. Maas, "Self, Personality, and Life Regulation: Facets of Psychological Resilience in Old Age," in *The Berlin Aging Study: Aging from 70 to 100*, ed. R. B. Baltes and K. U. Mayer (Cambridge: Cambridge University Press, 2001), 302–328.

6. R. C. Locsin, "Time Experience of Selected Institutionalized Clients," *Clinical Nursing Research* 2 (1993): 451–463.

7. D. Draaisma, *Why Life Speeds Up as We Get Older: How Memory Shapes the Past* (Cambridge: Cambridge University Press, 2001).

8. K. N. Ochsner and D. L. Schacter, "A Social Cognitive Neuroscience Approach to Emotion and Memory: The Neuropsychology of Emotion," in *The Neuropsychology of Emotion*, ed. J. C. Borod (New York: Oxford University Press, 2000), 163–193.

9. P. K. Quinn and M. Reznikoff, "The Relationship between Death Anxiety and the Subjective Experience of Time in the Elderly," *International Journal of Aging and Human Development* 21 (1985): 197–210.

10. L. L. Carstensen, "The Influence of a Sense of Time on Human Development," *Science* 312 (2006): 1913–1915.

11. K.-G. Tismer, "Interindividuelle Unterschiede der Zeitperspektive im mittleren und höheren Erwachsenenalter," in *Altern—Ein lebenslanger Prozeß der sozialen Interaktion*, ed. R. Schmitz-Scherzer, A. Kruse, and E. Olbrich (Darmstadt: Steinkopff, 1990), 233–242. In fact, a pronounced future perspective with many planned activities is a sign of healthy aging in an individual: P. E. R. Bitti, M. Zambianchi, and J. Bitner, "Time Perspective and Positive Aging," in *Time Perspective Theory: Review, Research, and Application*, ed. M. Stolarski, N. Fieulaine, W. van Beek (Cham: Springer International, 2015), 437–450.

12. G. Rudinger and H. Thomae, "The Bonn Longitudinal Study of Aging: Coping, Life Adjustment, and Life Satisfaction," in *Successful Aging: Perspectives from the Behavioral Sciences*, ed. P. B. Baltes and M. M. Baltes (Cambridge: Cambridge University Press, 1990), 265–295.

13. T. C. Vollmer, M. Wittmann, C. Schweiger, and W. Hiddemann, "Preoccupation with Death as Predictor of Psychological Distress in Patients with Haematologic Malignancies," *European Journal of Cancer Care* 20 (2011): 403–411; H. W. van Laarhoven, J. Schilderman, C. A. Verhagen, and J. B. Prins, "Time Perception of Cancer Patients without Evidence of Disease and Advanced Cancer Patients in a Palliative, End-of-Life-Care Setting," *Cancer Nursing* 34 (2011): 453–463.

14. P. K. Oles, "Towards a Psychological Model of Midlife Crisis," *Psychological Reports* 84 (1999): 1059–1069.

15. Another possible factor warrants consideration: life itself is accelerating. Technological, social, and political changes are enormous. In the course of a single life, the speed of events, political upheavals, and technological innovations that is perceived may itself increase. Viewed from this standpoint, time accelerates because cultural developments that used to take twenty years now occur in just two years. However, this explains only part of the phenomenon, at most. The experience of how fast time passes surely does not depend on whether typical technological developments have occurred—e.g., the shift from network telephones to hand-held devices with an integrated television. The question of the subjective experience of time in terms of the lifeworld involves many other aspects of developmental psychology, as sketched in this chapter.

16. The *Deutsche Forschungsgemeinschaft* project directed by Armin Nassehi and Georg Weber, "Todesbilder—Strukturen der Endlichkeit in der modernen Gesellschaft" (1999–2001), interviewed 150 people whose professions concerned death—or did not. The results are presented in I. Saake, "Moderne Todessemantiken," in *Moderne Mythen der Medizin*, ed. I. Saake and W. Vogel (Wiesbaden: VS Verlag für Sozialwissenschaften, 2008).

17. Otto Rank was initially the secretary of the Vienna Psychoanalytic Society founded by Sigmund Freud. As with so many fellow travelers of psychoanalysis—e.g., C. G. Jung or Alfred Adler—a break with Freud occurred when Rank developed theories of his own: see Rank, "Mankind's Psychological Article of Faith Is Immortality," in *Seelenglaube und Psychologie* (Leipzig, Vienna: Franz Deuticke, 1930). Translated by G. C. Richter and E. J. Lieberman as *Psychology and the Soul* (Baltimore: The Johns Hopkins University Press, 2003). In the 1970s, Ernest Becker popularized Rank's ideas in *The Denial of Death*, for which he was posthumously awarded the Pulitzer Prize (two years after his own death). According to Becker, the greatest heroes in a given society are those who died gloriously—that is, overcame their individual fear of death—for the common good.

18. Human behavior, especially religious-spiritual behavior, has changed dramatically over time, of course. Today, far fewer people attend church. Lived Christianity, after all, is the hope—if not the confident belief—that life will continue after death. However, some theorists view increased attendance of cultural events as a modern substitute. If one no longer explicitly believes in God, one may seek other forms of (cultural) transcendence—transcendence in the sense of something eternally valid, such as art or music.

19. A. Revonsuo, *Inner Presence: Consciousness as a Biological Phenomenon* (Cambridge, MA: MIT Press, 2006).

20. The "terror-management theory" as proposed by Jeff Greenberg, Sheldon Solomon, and Tom Pyszczynski, builds on the ideas of Otto Rank and Ernest Becker. These investigators try to empirically validate the claim of repressed thoughts about death. Their study results can be found in S. Solomon, J. Greenberg, and T. Pyszczynski, *The Worm at the Core: On the Role of Death in Life* (New York: Penguin Random House, 2015).

21. E. Tugendhat, *Über den Tod* (Frankfurt am Main: Suhrkamp, 2006).

22. Seneca, *On the Shortness of Life*, trans. C. D. N. Costa (New York: Penguin, 2005), 1.

23. As the former tutor and mentor of Nero, he was forced to commit suicide when suspected of participating in a conspiracy against the emperor. His whole life, Seneca stoically reflected on his own mortality, which a respiratory ailment constantly brought to mind. He is said to have gone to his death calmly.

6 Winning and Losing Time: The Self and Temporality

1. Immanuel Kant (1724–1804) proposed a solution to this puzzle in his *Critique of Pure Reason* by arguing that the subject does not belong to the world. The subject construes (in modern parlance, "constructs") the world but is not itself a part of the world. This means that the subject is transcendental, i.e., the conditions for the perception of internal and external experience are located in the subject, by means of which the objective world can be grasped. These conditions of the transcendental subject precede all experience (they are *a priori*). As such, the subject itself is not part of the world that can be experienced. Ludwig Wittgenstein summarizes the view pithily in 5.632 of his *Tractatus Logico-Philosophicus*: "The subject does not belong to the world but it is a limit of the world." This is like the relationship between the eye (subject) and the field of vision (which contains objects): "from nothing *in the field of sight* can it be concluded that it is seen from an eye" (5.633). Lambert Wiesing puts it as follows: "There is no phenomenal evidence of the self; and as long as this is required … the self must be given up. There is no self-knowledge, for the self is a secret to itself!" L. Wiesing, *The Philosophy of Perception: Phenomenology and Image Theory*, trans. Nancy Ann Roth (London: Bloomsbury, 2014), 77.

2. Wiesing, *The Philosophy of Perception*, viii, 76, 77.

3. D. Zahavi, *Subjectivity and Selfhood: Investigating the First-Person Perspective* (Cambridge MA: MIT Press, 2005).

4. Ibid., 126.

5. Wiesing, The Philosophy of Perception, 78.

6. T. Metzinger, *The Ego Tunnel: The Science of the Mind and the Myth of the Self* (New York: Basic, 2009). An encyclopedic work on the subject of the "self-model" that incorporates findings from philosophy and the neurosciences is T. Metzinger, *Being No One: The Self-Model Theory of Subjectivity* (Cambridge MA: MIT Press, 2004).

7. The question here is whether the conceptual shift of subjectivity, from "thing" to "process," changes anything fundamental about the self-image of the human being. After all, the presence of my sense of self in a lifeworld persists no matter what theories are offered. In terms of what I want, do, fear, and hope, nothing changes if I posit a Cartesian ego free of doubt or, following Thomas Metzinger, accept the self-model of the brain, which is based on neural activation patterns.

8. Metzinger, *The Ego Tunnel*, 60–61. Ernst Pöppel, in particular, has developed this idea: E. Pöppel, *Mindworks: Time and Conscious Experience* (Boston: Harcourt Brace Jovanovich, 1988).

9. Wiesing, *The Philosophy of Perception*, 106.

10. This reflection, offered by F. G. J. Schelling, was taken up by Heidegger in his lecture, "The Fundamental Concepts of Metaphysics"; Rüdiger Safranski puts it in a contemporary idiom in R. Safranski, *Martin Heidegger: Between Good and Evil* (Cambridge, MA: Harvard University Press, 1999).

11. The Russian neuropsychologist Aleksandr Luria (1902–1977) presents an exemplary account of the basic functions of the brain and disturbances that occur after brain injury: A. R. Luria, *The Working Brain: An Introduction to Neuropsychology* (New York: Basic, 1976).

12. Antonio Damasio's most recent discussion of the matter is found in *Self Comes to Mind: Constructing the Conscious Brain* (New York: Vintage, 2012).

13. A. D. Craig, "How Do You Feel? Interoception: The Sense of the Physiological Condition of the Body," *Nature Reviews Neuroscience* 3 (2002): 655–666.

14. The following draws on the ideas presented in A. D. (Bud) Craig, "How Do You Feel—Now? The Anterior Insula and Human Awareness," *Nature Reviews Neuroscience* 10 (2009): 59–68; A. D. Craig, *How Do You Feel? An Interoceptive Moment with Your Neurobiological Self* (Princeton: Princeton University Press, 2015). See also T. Singer, H. D. Critchley, and K. Preuschoff, "A Common Role of Insula in Feelings, Empathy, and Uncertainty," *Trends in Cognitive Sciences* 13 (2009): 334–340.

15. J. Kiverstein, "Consciousness, the Minimal Self, and Brain," *Psyche* 15 (2009): 59–74; D. Lloyd, "Neural Correlates of Temporality: Default Mode Variability and Temporal Awareness," *Consciousness and Cognition* 21 (2012): 695–703.

16. N. Medford and H. D. Critchley, "Conjoint Activity of Anterior Insular and Anterior Cingulate Cortex: Awareness and Response," *Brain Structure and Function* 214 (2010): 535–549.

17. M. P. Paulus, "Decision-Making Dysfunctions in Psychiatry—Altered Homeostatic Processing?" *Science* 318 (2007): 602–606.

18. M. P. Paulus and M. B. Stein, "An Insular View of Anxiety," *Biological Psychiatry* 60 (2006): 383–387.

19. A. D. Craig, K. Chen, D. Bandy, and E. M. Reiman, "Thermosensory Activation of Insular Cortex," *Nature Neuroscience* 3 (2000): 184–190.

20. The physiologist Emil Heinrich du Bois-Reymond pointed out the explanatory gap in a now-famous 1872 lecture, "Über die Grenzen des Naturerkennens" (trans. by J. Fitzgerald as "The Limits of Our Knowledge of Nature," *Popular Science Monthly* 5 [1874]), by showing how phenomenal states, as a matter of principle, cannot be grasped by the neurobiological understanding of brain states. The neurobiologist Hans Flohr discusses du Bois-Reymond's claims in an effort to show how neurobiology can, in fact, explain how phenomenal consciousness comes about: H. Flohr, "Brain Processes and Phenomenal Consciousness: A New and Specific Hypothesis," *Theory and Psychology* 1 (1991): 245–262.

21. J. M. Allman, N. A. Tetreault, A. Y. Hakeem, K. F. Manaye, K. Semendeferi, J. M. Erwin, S. Park, V. Goubert, and P. R. Hof, "The von Economo Neurons in Frontoinsular and Anterior Cingulate Cortex in Great Apes and Humans," *Brain Structure and Function* 214 (2010): 495–517.

22. In this context, it is worth considering the reflections offered by Peter Toohey, who offers an entertaining journey through boredom that incorporates art history, literature, psychology, and neurobiology: P. Toohey, *Boredom: A Lively History* (New Haven: Yale University Press, 2011).

23. Boredom has an altogether existential dimension: it points to the temporality of existence. Boredom as self-perception is also perception of the temporality of existence. It is possible only because each human being (*Dasein*) has a temporal extension, which, in an extended sense, points to the finitude of life. Heidegger's reflections on the matter may be found in *Being and Time*. The lectures, collected as *The Fundamental Concepts of Metaphysics: World, Finitude, Solitude*, trans. William McNeill and Nicholas Walker (Bloomington: Indiana University Press, 2001), make particular reference to the dimension of boredom.

24. Heidegger's paraphrase of St. Augustine's analysis in his *Confessions* captures the matter: "In you, my spirit, I measure times; you I measure, as I measure time. … My very finding myself disposed … is what I measure when I measure time" (Heidegger, *The Concept of Time*, trans. William McNeill [Oxford: Wiley-Blackwell, 1992], 6E).

25. Heidegger, *The Fundamental Concepts of Metaphysics*.

26. Ibid., 129–130. Jean Gebser (1905–1973) discusses "not having any time" in a similar fashion: "'I don't have any time'—these words one hears over and over coming from people today is symptomatic. 'Time,' if at first still in negative form, is modern man's greatest preoccupation. Whoever says so, thinks it concerns the time of the clock. How terrified would he be if he realized that, at the same time, he is also saying, 'I have no soul' and 'I have no life'!" J. Gebser, *The Ever-Present Origin, Part Two: Manifestations of the Aperspectival World*, trans. N. Barstad and A. Mickunas (Athens, OH: Ohio University Press, 1986).

27. H. Rosa, *Social Acceleration: A New Theory of Modernity*, trans. Jonathan Trejo-Mathys (New York: Columbia University Press, 2013).

28. The acceleration of the pace of life, according to Rosa (*Social Acceleration*, 123), can be identified in four spheres where there is an evident increase in the number of actions and experiences per time-unit given: (1) acceleration of actions: we walk, write, read, speak, and eat faster; (2) abridgment of pauses: coffee breaks and evening walks are omitted; (3) multitasking: we eat breakfast while at the same time watching the news, telephoning, and writing email; (4) slower processes are replaced by faster ones: we heat up frozen pizzas instead of cooking from scratch.

29. Milan Kundera formulates this feeling in his novel *Slowness*: "Speed is the form of ecstasy the technical revolution has bestowed on man. As opposed to a motorcyclist, the runner is always present in his body, forever required to think about his blisters, his exhaustion; when he runs he feels his weight, his age, more conscious than ever of himself and of his time of life. This all changes when man delegates the faculty of speed to a machine: from then on, his own body is outside the process, and he gives over to a speed that is noncorporeal, nonmaterial, pure speed, speed itself, ecstasy speed" (trans. Linda Asher [New York: Harper Perennial, 1997], 121).

30. Stefan Klein knowledgeably discusses the connections between temporal feeling and the experience of stress at work: S. Klein, *The Secret Pulse of Time: Making Sense of Life's Scarcest Commodity* (New York: Marlowe, 2007).

31. Stefan Klein (see the previous note) includes a series of steps one can take to gain control over time in the epilogue to his book. These steps, if at somewhat greater length, largely overlap with the points mentioned here: e.g., "celebrating" and savoring free time, living in the moment, learning to concentrate, and setting priorities to manage workloads.

7 Body Time: How the Sense of Time Arises

1. See, e.g., Aristotle's conception of time in the *Physics.*

2. J. C. Lilly, *The Deep Self: Consciousness Exploration in the Isolation Tank* (Nevada City, CA: Gateways, 2007).

3. D. G. Forgays and M. J. Belinson, "Is Flotation Isolation a Relaxing Environment?" *Journal of Environmental Psychology* 6 (1986): 19–34; C. A. Schulman, M. Richlin, and S. Weinstein, "Hallucinations and Disturbances of Affect, Cognition, and Physical State as a Function of Sensory Deprivation," *Perceptual and Motor Skills* 25 (1967): 1001–1024.

4. A. N. Simmons, T. M. Flagan, M. Wittmann, I. A. Strigo, S. C. Matthews, H. Donovan, J. B. Lohr, and M. P. Paulus, "The Effects of Temporal Unpredictability in Anticipation of Negative Events in Combat Veterans with PTSD," *Journal of Affective Disorders* 146 (2013): 426–432; A. N. Simmons, M. B. Stein, I. A. Strigo, E. Arce, C. Hitchcock, and M. P. Paulus, "Anxiety Positive Subjects Show Altered Processing in the Anterior Insula during Anticipation of Negative Stimuli," *Human Brain Mapping* 32 (2011): 1836–1846; I. A. Strigo, A. N. Simmons, S. C. Matthews, A. D. Craig, and M. P. Paulus, "Association of Major Depressive Disorder with Altered Functional Brain Response during Anticipation and Processing of Heat Pain," *Archives of General Psychiatry* 65 (2008): 1275–1284.

5. R. L. Aupperle, L. Ravindran, D. Tankersley, T. Flagan, N. R. Stein, A. N. Simmons, M. B. Stein, and M. P. Paulus, "Pregabalin Influences Insula and Amygdala Activation during Anticipation of Emotional Images," *Neuropsychopharmacology* 36 (2011): 1466–1477.

6. A. D. Craig, "Interoception and Emotion: A Neuroanatomical Perspective," in *Handbook of Emotion*, 3rd ed., ed. M. Lewis, J. M. Haviland-Jones, and L. F. Barrett (New York: Guilford, 2008), 272–288; A. D. Craig, "How Do You Feel—Now? The Anterior Insula and Human Awareness," *Nature Reviews Neuroscience* 10 (2009): 59–68.

7. To be thorough, one would have to consider many other conceptual dimensions of the study that space prohibits discussing here. To provide a single example relating to the construction of the study: to prevent subjects from counting—which was explicitly *not* desired —a secondary task had to be fulfilled during the primary temporal-processing task. At the beginning of each trial, subjects saw four numbers they were told to memorize. After the key for temporal reproduction had been pressed, a further number was provided. Subjects then had to decide, by pressing a key, whether this number was one of the four initially presented or not. The idea was that this secondary task would be easy enough not to impair temporal perception, yet would still make counting difficult. Other challenges arose especially because of the technology used to measure brain activity indirectly, functional magnetic resonance imaging (fMRI). Brain activity that is measured during a task must be contrasted with brain activity during a control task. Brain activity during the temporal task can only be interpreted in relation to the control task. The control task was designed as follows: tones were presented for the same spans of time that occurred in the temporal-duration task.

However, subjects were instructed to press a key as quickly as possible once the tone had ended. To perform this secondary task, subjects had to concentrate in a similar way; moreover, they were given the same task of memorizing numbers and had to perform an action—by pressing the key. The control task presented as many aspects of the temporal-duration task as possible—with the exception of temporal perception. The logic is as follows: heightened activity during the task of temporal perception, compared to the control task, is due exclusively to processes of temporal perception. This aspect and many other technical details of the study are to be found in M. Wittmann, A. N. Simmons, J. Aron, and M. P. Paulus, "Accumulation of Neural Activity in the Posterior Insula Encodes the Passage of Time," *Neuropsychologia* 48 (2010): 3110–3120. I owe particular thanks to Jan Churan and Alan Simmons for their active support in conceiving and programming the task. See also a review of the series of studies I undertook with this specific task: M. Wittmann, "The Inner Sense of Time: How the Brain Creates a Representation of Duration," *Nature Reviews Neuroscience* 14 (2013): 217–223.

8. As we provided the comparison stimulus (during temporal reproduction), a similar increase in activity occurred in the anterior insular cortex, as well as the lower part and medial sections of the frontal lobe. This activity peaked shortly before the subject pressed the key to indicate the interval reproduced. The shift of activity in the posterior insular lobe, during the target stimulus, to activity in the anterior insular lobe, during the comparison stimulus, might be interpreted as follows: during the presentation of the target stimulus, the subject constructs an initial representation of duration. However, during the presentation of the comparison stimulus, the subject must construct a kind of metarepresentation, which compares the first tone-duration (which has passed) with the one that was just heard. According to Craig, the anterior insular lobe is to be viewed as involved in integrating and creating metarepresentations ("I observe myself") (cf. chapter 6).

9. A. D. Craig, "Emotional Moments across Time: A Possible Neural Basis for Time Perception in the Anterior Insula," *Philosophical Transactions of the Royal Society B* 364 (2009): 1933–1942. Comprehensive meta-analyses are found in P. A. Lewis and R. C. Miall, "Distinct Systems for Automatic and Cognitively Controlled Time Measurement: Evidence from Neuroimaging," *Current Opinion in Neurobiology* 13 (2003): 250–255; M. Wiener, P. Turkeltaub, and H. B. Coslett, "The Image of Time: A Voxelwise Meta-analysis," *NeuroImage* 49 (2010): 1728–1740; and M. Wittmann, "The Inner Sense of Time: How the Brain Creates a Representation of Duration," *Nature Reviews Neuroscience* 14 (2013): 217–223.

10. For a good overview on studies with animals, see, e.g., M. A. Lebedev, J. E. O'Doherty, and M. A. L. Nicolelis, "Decoding of Temporal Intervals from Cortical Ensemble Activity," *Journal of Neurophysiology* 99 (2008): 166–186; D. Durstewitz, "Neural Representation of Interval Time," *Neuroreport* 15 (2004): 745–749.

11. K. Meissner and M. Wittmann, "Body Signals, Cardiac Awareness, and the Perception of Time," *Biological Psychology* 86 (2011): 289–297.

12. O. Pollatos, B. M. Herbert, C. Kaufmann, D. P. Auer, and R. Schandry, "Interoceptive Awareness, Anxiety, and Cardiovascular Reactivity to Isometric Exercise," *International Journal of Psychophysiology* 65 (2007): 167–173.

13. M. Guyau, *La genèse de l'idée de temps* (Paris: Félix Alcan, 1902).

14. A. Bobin-Bègue, J. Provasi, A. Marks, and V. Pouthas, "Influence of Auditory Tempo on the Endogenous Rhythm of Non-nutritive Sucking," *European Revue of Applied Psychology* 56 (2006): 239–245.

15. H. D. Critchley, S. Wiens, P. Rotshtein, A. Öhman, and R. J. Dolan, "Neural Systems Supporting Interoceptive Awareness," *Nature Neuroscience* 7 (2004): 189–195.

16. H. Ackermann, A. Riecker, K. Mathiak, M. Erb, W. Grodd, and D. Wildgruber, "Rate-dependent

Activation of a Prefrontal-Insular-Cerebellar Network during Passive Listening to Trains of Click Stimuli: An fMRI Study," *Neuroreport* 12 (2001): 4087–4092.

17. P. Hartocollis, *Time and Timelessness, or, The Varieties of Temporal Experience (A Psychoanalytic Inquiry)* (New York: International University Press, 1983).

18. For an overview of these studies, see M. Wittmann, "The Inner Sense of Time," *Philosophical Transactions of the Royal Society B* 364 (2009): 1955–1967.

19. F. N. Watts and R. Sharrock, "Fear and Time Estimation," *Perception and Motor Skills* 59 (1984): 597–598.

20. L. A. Campbell and R. A. Bryant, "How Time Flies: A Study of Novice Skydivers," *Behavior Research and Therapy* 45 (2007): 1389–1392.

21. J. M. Twenge, K. R. Catanese, and R. F. Baumeister, "Social Exclusion and the Deconstructed State: Time Perception, Meaninglessness, Lethargy, Lack of Emotion, and Self-Awareness," *Journal of Personality and Social Psychology* 85 (2003): 409–423.

22. As studies with imaging methods such as fMRI show, areas of bodily representation, including the insular cortex, are activated during meditation: N. A. S. Farb, Z. V. Segal, H. Mayberg, J. Bean, D. McKeon, Z. Fatima, and A. K. Anderson, "Attending to the Present: Mindfulness Meditation Reveals Distinct Neural Modes of Self-Reference," *Social Cognitive and Affective Neuroscience* 2 (2007): 313–322. For a conceptual overview of how time and the body are related in meditation practice, see M. Wittmann and S. Schmidt, "Mindfulness Meditation and the Experience of Time," in *Meditation—Neuroscientific Approaches and Philosophical Implications: Studies in Neuroscience, Consciousness, and Spirituality 2*, ed. S. Schmidt and H. Walach (Berlin: Springer, 2013), 199–210.

23. Documentation of the performance *The Artist Is Present* can be found on the MoMA website: http://www.moma.org/visit/calendar/exhibitions/965.

Image Credits

Figure 4: akg-images.

Figure 5: Photo: © Dirk Thiel.

Figure 6: From E. Gutyrchik, J. Churan, T. Meindl, A.L.W. Bokde, H. von Bernwitz, C. Born, M. Reiser, E. Pöppel, and M. Wittmann, “Functional Neuroimaging of Duration Discrimination on Two Different Time Scales,” *Neuroscience Letters* 469 (2010): 411–415.

Figure 7: From M. Wittmann and S. Lehnhoff, “Age Effects in the Perception of Time,” *Psychological Reports* 97 (2005): 921–935.

Figure 8: © Bavarian National Museum, Munich.

Table of Contents

Half Title
Title
Copyright
Contents
Achknowledgments
Introduction
1 Temporal Shortsightedness: On Being Able to Wait
2 Looking for the Rhythm of the Brain
3 In the Moment: Three Seconds of Presence
4 Internal Clocks: What We “Need” Time For
5 Life, Happiness, and the Ultimate Time Limit
6 Winning and Losing Time: The Self and Temporality
7 Body Time: How the Sense of Time Arises
Notes
Image Credits