

PART I

Introduction  
and Overview



# Introduction: Toward an Interdisciplinary Science of Spontaneous Thought

Kieran C. R. Fox *and* Kalina Christoff

## Abstract

Enormous questions still loom for the emerging science of spontaneous thought: What, exactly, is spontaneous thought? Why does the human brain engage in spontaneous forms of thinking, and when is this most likely to occur? And perhaps the question most interesting and accessible from a scientific perspective: How does the brain generate, elaborate, and evaluate its own spontaneous creations? The central aim of this volume is to bring together views from neuroscience, psychology, philosophy, phenomenology, history, education, contemplative traditions, and clinical practice in order to begin to address the ubiquitous but poorly understood mental phenomena that is collectively called “spontaneous thought.” Perhaps no other mental experience is so familiar in daily life, and yet so difficult to understand and explain scientifically. The present volume represents the first effort to bring such highly diverse perspectives to bear on answering the what, when, why, and how of spontaneous thought.

**Key Words:** mind-wandering, creativity, dreaming, daydreaming, spontaneous thought, self-generated thought

## Where Do Spontaneous Thoughts Come From?

It may be surprising that the seemingly straightforward answers “from the mind” or “from the brain” are in fact an incredibly recent, modern understanding of the origins of spontaneous thought. For nearly all of human history, our thoughts—especially the most sudden, insightful, and important—were almost universally ascribed to divine or other external sources. Cultures around the world believed that dreams were messages sent from the gods (Kracke, 1991); inventions like writing and agriculture were credited to ancient culture heroes and tutelary deities long lost in the mists of legend (Chang, 1983); and the belief that artistic creativity was inspired by the Muses (Murray, 1989) held sway for two millennia (McMahon, 2013). Even the original sense of the word *inspiration* was that the divine had been “breathed into” a mere mortal, accounting for the new idea or insight. There were of course exceptions—Aristotle, for instance, put forward the naturalistic hypothesis that dreams

were created by the mind of the dreamer (Gallop, 1996)—but nowhere, it seems, was there a widespread belief in the spontaneity, originality, and creativity of the unaided human mind.

We still sometimes worship our great intellectual innovators—artists, scientists, philosophers—as semi-divine figures. But somewhere, somehow, our perspective changed and we began to see ourselves as the authors of our own thoughts, however inexplicable their origins might seem. Perhaps the beginnings of this shift in perspective are echoed in the ancient myth of Prometheus, who “stole and gave to mortals” the “fount of the arts, the light of fire”—in other words, the power of conjuring up novel thoughts (Griffith, 1983). Although this internalization of thought’s origins began long ago, only in the past few centuries have human beings truly taken responsibility for their own mental content, and finally localized thought to the central nervous system—laying the foundations for a protoscience of spontaneous thought.

This shift has broadly answered the *who* and the *where* of spontaneous thought: we are the source of our thoughts, and these thoughts seem to be constructed in our heads. But enormous questions still loom: *What*, exactly, is spontaneous thought? *Why* does our brain engage in spontaneous forms of thinking, and *when* is this most likely to occur? And perhaps the most interesting and accessible question from a scientific perspective: *How* does the brain generate, elaborate, and evaluate its own spontaneous creations? Each chapter that follows aims to provide at least preliminary answers to these perplexing questions.

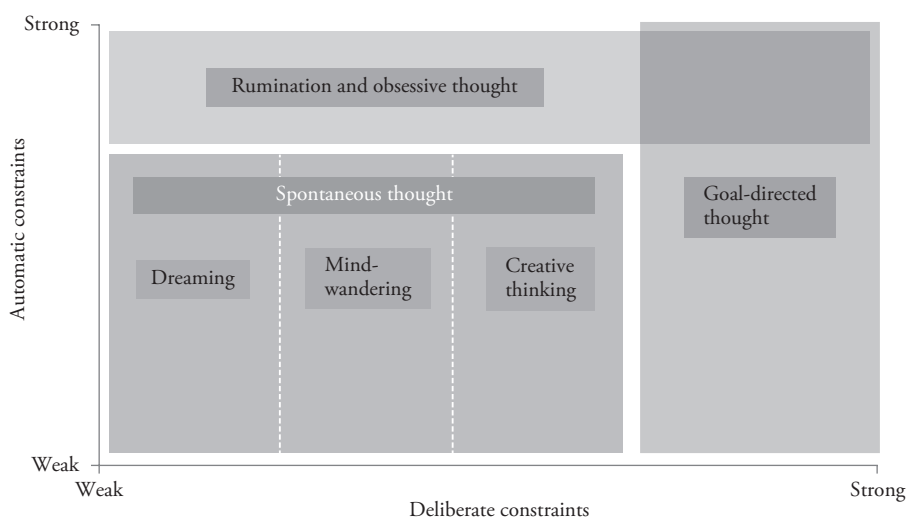
The central aim of this volume is to bring together views from neuroscience, psychology, philosophy, phenomenology, history, education, contemplative traditions, and clinical practice in order to begin to address the ubiquitous but poorly understood mental phenomena that we collectively call “spontaneous thought.” Perhaps no other mental experience is so familiar to us in daily life, and yet so difficult to understand and explain scientifically. The present volume represents the first effort to bring such highly diverse perspectives to bear on answering the what, when, why, and how of spontaneous thought.

Although “spontaneous thought” as a term has been used throughout the last decade in both the psychological (Klinger, 2008) and neuroscientific literature (Christoff, Irving, Fox, Spreng, & Andrews-Hanna, 2016; Christoff, Ream, & Gabrieli, 2004; Fox, Spreng, Ellamil, Andrews-Hanna, & Christoff, 2015), recent years have marked tremendous

progress in our theoretical understanding of what spontaneous thought is and what phenomena it encompasses. Spontaneous thought can be defined as thought that arises relatively freely due to an absence of strong constraints on its contents or on the transitions from one mental state to another (Christoff et al., 2016). In other words, spontaneous thought moves freely as it unfolds (Figure 1.1).

There are two general ways in which thought can be constrained (Figure 1.1). One type of constraint is flexible and deliberate, and is implemented through cognitive control. Another type of constraint is automatic in nature. Automatic constraints can be thought of as a family of mechanisms that operate outside of cognitive control to hold attention on a restricted set of information. Examples of automatic constraints are emotional significance and habits, both of which can constrain our thoughts without any effort or intention on our part (Christoff et al., 2016; Fox, Kang, Lifshitz, & Christoff, 2016; Todd, Cunningham, Anderson, & Thompson, 2012).

Spontaneous thought can also be understood as a broader family of mental phenomena, including our daytime fantasies and mind-wandering (Christoff, 2012; Fox et al., 2015); the flashes of insight and inspiration familiar to the artist, scientist, and inventor (Beaty, Benedek, Silvia, & Schacter, 2016; Kounios & Beeman, 2014; Zabelina & Andrews-Hanna, 2016); and the nighttime visions we call dreams (Christoff et al., 2016; Domhoff & Fox, 2015; Fox, Nijeboer, Solomonova, Domhoff, & Christoff, 2013). There is a dark side to spontaneous



**Figure 1.1.** Conceptual space relating different types of thought and their constraints. Reproduced, with permission, from Christoff et al. (2016). (See Color Insert)

thought as well—the illumination of which is yet another major goal of this volume. Repetitive depressive rumination, uncontrollable thoughts in obsessive-compulsive disorder, the involuntary and lifelike re-experiencing of post-traumatic stress disorder—all these, we suggest, can be considered dysfunctional forms of spontaneous thought, and need to be understood in relation to our natural and healthy propensity toward novel, variable, imaginative thought (Christoff et al., 2016; see also Mills et al., Chapter 2 in this volume).

*Spontaneous* should in no way suggest *random* or *meaningless*. Another key aim of this volume is to highlight the ample evidence in favor of the idea that goal-related and “top-down” processing often co-occurs with and can sometimes guide spontaneous thought (Fox & Christoff, 2014; Fox et al., 2016; Klinger & Cox, 2011; Seli, Risko, Smilek, & Schacter, 2016). Although the cause and meaning of specific thoughts or dreams often elude us, the rare but sensational occurrences of transgressive thoughts or highly bizarre and emotional dreams tend to obscure just how mundane (but, quite possibly, useful) most of our self-generated mental content really is (Domhoff, 2003; Fox et al., 2013; Klinger, 2008). The degree to which mental processes that are ostensibly spontaneous and beyond our control appear to be planned, relevant, and insightful with respect to our personal goals and concerns is striking—and, we believe, deserving of further exploration.

These ubiquitous spontaneous mental phenomena raise some intriguing questions: Can we engage in planning and other executive processes in the absence of conscious awareness? To what extent are “we” in control of our own minds? The true qualities and content of spontaneous thought also fly in the face of many culturally sanctioned but unwarranted beliefs about the inexplicability of our fantasy lives, the randomness and meaninglessness of dreams, or the disorderliness of creative thoughts and insights in artists and scientists. A closer look at psychological, neuroscientific, and philosophical work shows not only the co-occurrence of cognitive processes like planning, mentalizing, and metacognition with various forms of spontaneous thought (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Fox & Christoff, 2014; Fox et al., 2015; Seli et al., 2016), but also a compelling correspondence between the content of one’s spontaneous thoughts and the content and concerns of one’s daily life (Klinger, 2008). *The Oxford Handbook of Spontaneous Thought* is the first volume of its kind to

bring together experts from so many diverse fields to explore these phenomena, and should therefore be of interest to psychologists, neuroscientists, philosophers, clinicians, educators, and artists alike—indeed, to anyone intrigued by the incredibly rich life of the mind.

### Overview of the *Handbook*

This *Handbook* is divided into seven separate but closely interrelated parts. This introductory chapter comprises Part I, providing an overview of spontaneous thought in general and the many chapters of this book in particular.

Part II dives right into fundamental theoretical issues surrounding the definition and investigation of spontaneous thought. In Chapter 2, Caitlin Mills, Arianne Herrera-Bennett, Myrthe Faber, and Kalina Christoff ask why the mind wanders at all, and propose the default variability hypothesis: the idea that by default, spontaneous thought tends to exhibit high variability of content over time—variability that serves as an adaptive mechanism that enhances episodic memory efficiency and facilitates semantic knowledge optimization. Chandra Sripada, in Chapter 3, puts forward a theoretical framework within which spontaneous and deliberate thought can be compared, respectively, with “exploration” of the environment in search of new resources versus “exploitation” of the resources we already have at hand. In Chapter 4, Carey Morewedge and Daniella Kupor provide an overview of people’s metacognitive appraisals of the meaning and relevance of spontaneous thoughts, with the surprising conclusion that people tend to attribute *more* importance to thought whose origin is mysterious—perhaps hearkening back to the ancient human view of the origins of thought discussed at the outset of this chapter. Dylan Stan and Kalina Christoff, in Chapter 5, propose that a key quality of mind-wandering is an accompanying subjective experience of *ease*, or low motivational intensity. In Chapter 6, Georg Northoff proposes a novel theory aiming to explain how spontaneous brain activity generates and constitutes subjectively experienced spontaneous thought. Finally, in Chapter 7, Jonathan Smallwood, Daniel Margulies, Boris Bernhardt, and Elizabeth Jeffries present their component process framework of spontaneous thought, explaining how different types of thought can arise through the interaction of specific underlying neurocognitive processes.

Part III explores the broader philosophical, evolutionary, and historical perspectives on spontaneous

thought. In Chapter 8, Zachary Irving and Evan Thompson provide an in-depth introduction to the philosophy of mind-wandering, reviewing several psychological and philosophical accounts and providing a new view of their own. Thomas Metzinger, in Chapter 9, addresses the question, “Why is mind-wandering interesting for philosophers?” In Chapter 10, Dean Keith Simonton relates the spontaneity of human thought to other spontaneous generative processes, highlighting the connections with “selectionist” views of evolution and creativity. John Antrobus, in Chapter 11, offers an analysis of how the brain in both waking and sleeping can so effortlessly produce a constant stream of visual imagery and thoughts—and what use they might have. Rounding out Part III, Alex Soojung-Kim Pang, in Chapter 12, explores how spontaneous thought was viewed in the past, how it was used by creative people to further their endeavors, and how deep historical research could lead to an understanding of the role of spontaneous thought in the history of ideas.

Part IV focuses on mind-wandering and daydreaming. In Chapter 13, Jessica Andrews-Hanna, Zachary Irving, Kieran Fox, Nathan Spreng, and Kalina Christoff present an interdisciplinary overview of the rapidly evolving neuroscience of spontaneous thought. Investigating what we have learned from intracranial electrophysiology in humans, Kieran Fox, in Chapter 14, then synthesizes the available evidence on how and where self-generated thought is initiated within the brain. In Chapter 15, Arnaud D’Argembeau provides a detailed discussion of the link between mind-wandering and self-referential thinking, and their common neural basis. David Stawarczyk, in Chapter 16, provides a detailed overview of the phenomenological properties of all kinds of mind-wandering and daydreaming, covering both the historical trajectory of these investigations and the present state of research. In Chapter 17, Eric Klinger, Igor Marchetti, and Ernst Koster discuss the critical importance of goal pursuit to spontaneous thought, elaborating on how these thoughts are adaptive in everyday life but can go awry in a variety of clinical conditions. Claire Zedelius and Jonathan Schooler, in Chapter 18, provide a fine-grained view of the many different kinds of mind-wandering and the evidence that they have distinctive effects on task performance, mood, and creativity. In Chapter 19, Julia Kam and Todd Handy comprehensively review the evidence from human electrophysiology that mind-wandering involves a decoupling of attention from

the external world. Finally, Jeffrey Wammes, Paul Seli, and Daniel Smilek, in Chapter 20, review what we know about mind-wandering in educational settings, and how excessive, unintentional mind-wandering in the classroom impacts learning and academic performance.

Part V covers creativity and insight, and their relation to other forms of spontaneous thought. Roger Beaty and Rex Jung, in Chapter 21, offer an overview of how large-scale brain networks interact during creative thinking and creative performance. In Chapter 22, Mathias Benedek and Emanuel Jauk offer detailed empirical evidence for a “dual-process” model of creative cognition, wherein the flexible switching between controlled and spontaneous cognition is critical to an optimal creative process. Charles Dobson, an artist as well as a professor of fine arts, offers in Chapter 23 an insider’s view of what he calls “flip-flop thinking,” and outlines his firsthand experiences of what helps (and what hurts) the creative process. In Chapter 24, John Vervaeke, Leo Ferraro, and Arianne Herrera-Bennett develop an intriguing account of the “flow” state as a form of spontaneous thought characterized by a cascade of successive insights and learning experiences. Oshin Vartanian, in Chapter 25, delves into how self-referential thoughts can be elicited by aesthetic appreciation of artworks, such as paintings. Finally, in Chapter 26, David Beversdorf provides an extensive review of the neurochemical basis of flexible and creative thinking.

Spontaneous thought does not cease when we close our eyes and turn out the lights. Part VI explores the many normal, extraordinary, and sometimes pathological varieties of spontaneous thought that take place throughout the sleep cycle, and how these are related to memory consolidation and involuntary memory retrieval. In Chapter 27, G. William Domhoff provides an overview of the neural basis of dreaming and REM sleep, while Chapter 28, by Kieran Fox and Manesh Girm, provides a comprehensive review of what is known about the neural correlates of all sleep stages throughout the sleep cycle. In Chapter 29, Jennifer Windt and Ursula Voss provide an in-depth treatment of the phenomenon of lucid dreaming, bringing psychological, philosophical, and neuroscientific perspectives to bear to better explain this remarkable mental state. Tore Nielsen, in Chapter 30, explores the fascinating topic of “microdreaming” and hypnagogic imagery as a paradigm for a fine-scaled neurophenomenological approach to inner experience. In Chapter 31, Elizaveta Solomonova offers an

interdisciplinary look at the little-known phenomenon of sleep paralysis, and the spontaneous visions and emotions that accompany it. Erin Wamsley, in Chapter 32, explores how spontaneous thought in both waking and sleep can be seen as an expression of memory consolidation and recombination, and John Mace, in Chapter 33, provides a comprehensive overview of involuntary memories—how often they occur, how they can chain together, how they differ from voluntarily recalled information, and what their function might be.

Part VII takes us to the fringes and also the cutting edge of research on spontaneous thought: its relationship to clinical conditions and altered states of consciousness. Dylan Stan and Kalina Christoff begin, in Chapter 34, by outlining the many potential clinical benefits and risks of spontaneous thought. In Chapter 35, Claire O’Callaghan and Muireann Irish describe the neural underpinnings of how spontaneous thought changes in relation to aging and dementia syndromes. Elizabeth DuPre and Nathan Spreng, in Chapter 36, explore the relationships between depression, rumination, and spontaneous thought. In Chapter 37, Aaron Kucyi explores the intriguing relationships between mind-wandering and both chronic and acute pain, and how these interactions are mediated by large-scale brain networks. Halvor Eifring, in Chapter 38, investigates how religious and contemplative traditions around the world have tended to see mind-wandering as an obstacle, while at the same time viewing spiritual attainment and liberation as a spontaneous process of transformation that cannot be actuated deliberately. In Chapter 39, Wendy Hasenkamp outlines how meditation and mindfulness practices can provide a window into the rapid fluctuations of mind-wandering. Peter Suedfeld, Dennis Rank, and Marek Maluš offer in Chapter 40 an account of spontaneous thought in extreme and unusual environments, exploring rarely seen records of the thoughts and experiences of polar explorers, astronauts, and those undergoing severe sensory deprivation. Finally, Michael Lifshitz, Eli Sheiner, and Laurence Kirmayer detail in Chapter 41 how the powerful unconstrained cognition brought on by psychedelic substances can be guided by culture and context.

All told, these chapters provide the most comprehensive overview of the wide-ranging field of spontaneous thought to date—and there could be no better guides to this realm than the 64 outstanding scientists, historians, philosophers, and artists who have come together to write them.

Spontaneous forms of thought enable us to transcend not only the here and now of perceptual experience, but also the bonds of our deliberately controlled and goal-directed cognition; they allow the space for us to be other than who we are, and for our minds to think beyond the limitations of our current viewpoints and beliefs. In studying such an abstruse and seemingly impractical subject, we need always to remember that our capacity for spontaneity, originality, and creativity defines us as a species—and as individuals.

The painting adorning the cover of this *Handbook* is by artist and neuroscientist Greg Dunn, who draws inspiration for his work from the ancient *sumi-e* tradition of ink wash painting still practiced in Japan. The essence of *sumi-e*, which has deep roots in Taoism and Zen Buddhism, is to combine discipline with spontaneity, to evoke a complex essence with simplicity—to bring order, so to speak, out of chaos, and to give rise to a creation that is coherent and integrated, yet natural and unforced (Cheng, 1994; Van Briessen, 2011; Watts, 1957). We could think of no better artist to provide a visual overture to the multifaceted exploration of these same themes throughout the pages of this book.

Philosopher Alan Watts eloquently captured the tension and interplay between spontaneity and purpose when he wrote, “spontaneity is not by any means a blind, disorderly urge, a mere power of caprice. A philosophy restricted [by] conventional language has no way of conceiving an intelligence which does not work according to plan, according to a one-at-a-time order of thought. Yet the concrete evidence of such an intelligence is right to hand . . .” (Watts, 1957, p. 17). We hope the chapters that follow help to illuminate this elusive wisdom of spontaneous thought in all its many manifestations.

## References

- Beaty, R. E., Benedek, M., Silvia, P. J., & Schacter, D. L. (2016). Creative cognition and brain network dynamics. *Trends in Cognitive Sciences*, 20(2), 87–95.
- Chang, K. (1983). *Art, myth, and ritual: The path to political authority in ancient China*. Cambridge, MA: Harvard University Press.
- Cheng, F. (1994). *Empty and full: The language of Chinese painting*. Boston: Shambhala.
- Christoff, K. (2012). Undirected thought: Neural determinants and correlates. *Brain Research*, 1428, 51–59. doi: 10.1016/j.brainres.2011.09.060
- Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *Proceedings of the National Academy of Science U S A*, 106(21), 8719–8724. doi: 10.1073/pnas.0900234106

- Christoff, K., Irving, Z. C., Fox, K. C. R., Spreng, R. N., & Andrews-Hanna, J. R. (2016). Mind-wandering as spontaneous thought: A dynamic framework. *Nature Reviews Neuroscience*, *17*, 718–731.
- Christoff, K., Ream, J. M., & Gabrieli, J. D. E. (2004). Cognitive and neural basis of spontaneous thought processes. *Cortex*, *40*, 623–630.
- Domhoff, G. W. (2003). *The scientific study of dreams: Neural networks, cognitive development, and content analysis*. Washington, DC: American Psychological Association.
- Domhoff, G. W., & Fox, K. C. R. (2015). Dreaming and the default network: A review, synthesis, and counterintuitive research proposal. *Consciousness and Cognition*, *33*, 342–353.
- Fox, K. C. R., & Christoff, K. (2014). Metacognitive facilitation of spontaneous thought processes: When metacognition helps the wandering mind find its way. In S. M. Fleming & C. D. Frith (Eds.), *The cognitive neuroscience of metacognition* (pp. 293–319). Berlin: Springer.
- Fox, K. C. R., Kang, Y., Lifshitz, M., & Christoff, K. (2016). Increasing cognitive-emotional flexibility with meditation and hypnosis: The cognitive neuroscience of de-automatization. In A. Raz & M. Lifshitz (Eds.), *Hypnosis and meditation: Toward an integrative science of conscious planes* (pp. 191–219). New York: Oxford University Press.
- Fox, K. C. R., Nijboer, S., Solomonova, E., Domhoff, G. W., & Christoff, K. (2013). Dreaming as mind wandering: Evidence from functional neuroimaging and first-person content reports. *Frontiers in Human Neuroscience*, *7*, 412. doi: 10.3389/fnhum.2013.00412
- Fox, K. C. R., Spreng, R. N., Ellamil, M., Andrews-Hanna, J. R., & Christoff, K. (2015). The wandering brain: Meta-analysis of functional neuroimaging studies of mind-wandering and related spontaneous thought processes. *NeuroImage*, *111*, 611–621.
- Gallo, D. (1996). *Aristotle on sleep and dreams: A text and translation*. Cambridge: Cambridge University Press.
- Griffith, M. (1983). *Aeschylus: Prometheus bound*. Cambridge: Cambridge University Press.
- Klinger, E. (2008). Daydreaming and fantasizing: Thought flow and motivation. In K. D. Markman, W. M. P. Klein, & J. A. Suhr (Eds.), *Handbook of imagination and mental simulation* (pp. 225–239). New York: Psychology Press.
- Klinger, E., & Cox, W. M. (2011). Motivation and the goal theory of current concerns. In W. M. Cox & E. Klinger (Eds.), *Handbook of motivational counseling: Goal-based approaches to assessment and intervention with addiction and other problems* (pp. 1–47). Chichester, UK: John Wiley & Sons.
- Kounios, J., & Beeman, M. (2014). The cognitive neuroscience of insight. *Annual Review of Psychology*, *65*, 71–93.
- Kracke, W. (1991). Languages of dreaming: Anthropological approaches to the study of dreaming in other cultures. In J. Gackenbach & A. A. Sheikh (Eds.), *Dream images: A call to mental arms* (pp. 203–224). Amityville, NY: Baywood.
- McMahon, D. (2013). *Divine fury: A history of genius*. New York: Basic Books.
- Murray, P. (1989). *Genius: The history of an idea*. Oxford: B. Blackwell.
- Seli, P., Risko, E. F., Smilek, D., & Schacter, D. L. (2016). Mind-wandering with and without intention. *Trends in Cognitive Sciences*, *20*(8), 605–617.
- Todd, R. M., Cunningham, W. A., Anderson, A. K., & Thompson, E. (2012). Affect-biased attention as emotion regulation. *Trends in Cognitive Sciences*, *16*(7), 365–372.
- Van Briessen, F. (2011). *The way of the brush: Painting techniques of China and Japan*. North Clarendon, VT: Tuttle.
- Watts, A. W. (1957). *The way of Zen*. New York: Pantheon Books.
- Zabelina, D. L., & Andrews-Hanna, J. R. (2016). Dynamic network interactions supporting internally-oriented cognition. *Current Opinion in Neurobiology*, *40*, 86–93.