

Contents

Acknowledgments	vii
Prologue	xiii
I Cognition and the Essence of Control	1
1 Interference	3
2 Goals and Cognitive Control	19
3 The Brain and Control	39
4 Control Limitations	63
5 Variations and Fluctuations	81
II Behavior in a High-Tech World	99
6 The Psychology of Technology	101
7 The Impact of Constantly Shifting Our Attention	123
8 The Impact of Technology on Diverse Populations	143
9 Why Do We Interrupt Ourselves?	159
III Taking Control	181
10 Boosting Control	183
11 Modifying Behavior	213
Notes	239
Index	279

Acknowledgments

THIS STORY OF *The Distracted Mind* began for me in 2002 when I moved to San Francisco from the East Coast for a postdoctoral fellowship in cognitive neuroscience at UC Berkeley. I was searching for a research project that was not driven solely by the goal of advancing psychological theory, but rather one that everyday people would care about because its results would teach them something about their minds that truly mattered to them. And so, inspired by repeatedly hearing descriptions of the negative impact of distraction on the lives of my older patients at the neurology clinic at UC San Francisco, I set out to study the impact of distraction on memory.

- I would like to start by acknowledging those patients who were trusting enough to allow me to peer into their lives as they shared with me their insecurities and the fragilities of their minds. They were the first to open my eyes to the reality of the Distracted Mind.
- I am grateful to my first scientific mentor, John Morrison, and my mentors at UC Berkeley who gave me the opportunity, encouragement, and intellectual support to launch this research program: Mark D'Esposito and Robert Knight.
- I thank my lab mates who helped me develop and test the paradigms we used to assess the neural mechanisms of distractibility, which are referenced throughout the book: Brian Miller, Jesse Rissman, Jeff Cooney, Aaron Rutman, Kevin McEvoy, Tyler Seibert, Jon Kelley, and Darya Pino (now Darya Rose). Darya deserves special thanks for over a decade of enlightening discussions on this topic.
- I am indebted to the team of faculty, postdocs, research associates, and students from my lab, who worked tirelessly over many years to elucidate the details of

what occurs in our brains to generate the Distracted Mind, and how we might remediate its negative impact: Theodore Zanto, Wes Clapp, Zack Chadick, Michael Rubens, Jacob Bollinger, Jonathan Kalkstein, Jyoti Mishra, Joaquin Anguera, Ezequiel Morsella, Anne Berry, Peter Wais, Brad Voytek, Nate Cashdollar, Cammie Rolle, Judy Pa, David Ziegler, WanYu Hsu, Omar Al-Hashimi, Jacki Janowich, Jean Rintoul, and Jaqueline Boccanfuso. Sincere thanks to the many other members of our lab who assisted on these projects, the volunteer interns who made all of this research possible, and of course the hundreds of research participants over the years who gave so much time and effort to advance our science.

The next phase of the story began in 2009, when I was invited to give a talk at the Annual AARP meeting. This was the first presentation of my research on distraction that opened my eyes to the power of sharing science with the public. It led to hundreds of talks around the world over the subsequent years and my PBS special, *The Distracted Mind with Adam Gazzaley*.

- I acknowledge all of those audience members who asked so many wonderful, heartfelt questions, which drove me to search deeper for answers to the issues that people really care about.
- I thank Lennlee Keep and the team from Santé Fe Productions who encouraged and guided me through the intense process of creating the PBS show. That journey helped me distill my thoughts on this topic and learn how to best share it with the public.

My story of the Distracted Mind culminated with the writing of this book. The truth is I really did not want to write a book at all; I spend so much of time in scientific writing and I most enjoy the stage and film when it comes to sharing with the public.

- I would not have written this book if not for Larry Rosen. His enthusiasm for this project and the valuable insights he brought to the collaboration in terms of the impact of technology on the Distracted Mind convinced me that this story needed to be told with the depth and breadth that can only be achieved with a book.
- I thank our agent Stacey Glick, who has always had our back; Bob Prior, at the MIT Press, who believed in this book from the very beginning; Cammie Rolle,

who helped with literature research; and our copy editor, Judith Feldmann, who put up with all of our pickiness.

Finally, a deep thank you to my wife and love, Jo Gazzaley, who contributed tireless attention to refining the details of this book. For her selfless devotion to working by my side to elevate this book to the next level, I am eternally grateful.

—AG

A FEW YEARS AGO, after publishing my fifth book on the psychological impact of technology, I wondered whether there was anything left for me to say in the long format of a book rather than in my shorter blog posts. I had written about how technology was starting to make us crazy in *TechnoStress* (way back in 1997!), about parenting high-tech children in *Me, MySpace, and I* (2007), and about educating a new generation of tech-savvy students in *Rewired* (2010). In 2012 I wrote about how we were all becoming obsessed with our technology in *iDisorder* and in 2015 I coedited the Wiley-Blackwell handbook, *Psychology, Technology, and Society*. As I immersed myself in my lab's psychological research I realized that to fully understand the impact of technology I had to expand my perspective to the field of neuroscience. Serendipitously, after delivering the opening keynote at the Learning and the Brain Conference in San Francisco, I attended a session on multitasking and was blown away by Dr. Adam Gazzaley's carefully crafted neuroscience research. I rarely take notes at conferences and found myself with several pages of results and diagrams followed by immersing myself into the groundbreaking work coming out of his lab, including being spellbound by his video lecture on the Distracted Mind. Out of the blue I sent Adam an email and after a few back-and-forth emails and a couple of long phone calls we decided to write this book together. I was overjoyed. This book combines our two specialty areas—neuroscience and psychology—in a unique look at how and why we have become such a distracted society.

I am deeply indebted to Dr. Mark Carrier and Dr. Nancy Cheever—my cofounders of the George Marsh Applied Cognition Lab at California State University, Dominguez Hills—as well as all the undergraduate and graduate students who have worked on research in our lab. By my count in the six years since we combined our research into one lab, we have minted two PhDs and currently have fifteen GMAC Lab grads in PhD programs, along with others having completed their MA degrees and working in the field. Special thank go to Alex Lim, MA, who is our fourth lab “mentor” and tirelessly runs our new neuroscience lab.

I would be remiss if I did not acknowledge the role that California State University, Dominguez Hills, has played in the last forty-one years of my life. CSUDH is a small state university and many of our students are the first in their family to attend college, let alone aspire for a higher degree. The campus has supported my work by allowing me to teach “The Global Impact of Technology” for the last ten years—the only class taught in the university theater—to 450 students each semester. They have furthered my work by providing me with eager students and by funding our research with small grants here and there to keep our lab running. Federal programs support many of our students, and we thank the McNair Scholars Program, MBRS-RISE, and MARC-USTAR, for their support. President Willie Hagan deserves a special thank you for funding our neuroscience lab after hearing me speak to several campus groups about the coming need for neuropsychological research to complement and expand our lab focus on the “psychology of technology.”

On a personal level I could not complete any book without my fiancée Dr. Vicki Nevins who has supported me through the last five books even though I kept saying that each book was my last. She listened and applauded me when I was high from a great writing day, and commiserated with me when I was frustrated on less productive days. My four children and their spouses are all amazing. Adam and Farris, Arielle and Jess, Chris and Tiffany, and Kaylee and Grant take time to make sure we share our lives even though none of them live close enough to see face to face all that often. We text, FaceTime, Facebook, and actually (gasp) talk on the phone, and I feel their love and caring with me 24/7. Three special hugs go to Grayson (my

granddaughter) and Evan and Michael (Vicki's grandsons, who have always called me grandpa even though I am technically not yet "official").

A big thank you goes to Bob Prior at the MIT Press for believing in this book. Judith Feldmann did a wonderful copyediting job amid our cutting and pasting and moving and adding. Adam's wife, Jo Gazzaley, played a major role in reading the entire manuscript many times and finding areas for enhancement, correction, and improvement. Last, but certainly not least, Stacey Glick has been my agent for my last five books and has always been available to help me understand the publishing world.

—LDR

Prologue

THIS BOOK IS the first of its kind to explore the daily challenges we face with the highly engaging but extremely distracting high-tech world we now inhabit, from the dual points of view of a psychologist and a neuroscientist. By providing both scientific foundations and real-world examples of people facing and addressing their own distracted minds, we share with you a unique perspective on how our increasingly information-saturated world (overflowing with pop-up windows, smartphones, texts, chat, email, social media, and video games) has coupled with growing expectations of 24/7/365 availability and immediate responsiveness to place excessive demands on our brains. *The Distracted Mind* will take you on a journey into how and why we struggle with interruptions and distractions that emerge from both our inner and outer worlds, as well as offer practical strategies for changing your behavior and enhancing your brain function to alleviate interference and better accomplish your goals. It is clear that our interruptive technologies are only going to become more effective in drawing our attention away from important aspects of life, so we urgently need to understand why we are so sensitive to interference and how we can find a “signal amidst the noise” in our high-tech world.

The Distracted Mind is not a pseudo-science book that offers colorful brain scans and questionable neuroscience as a way of making a topic appear more credible. In this book, we apply our complementary scientific lenses to present timely and practical insights. Dr. Adam Gazzaley is a cognitive neuroscientist and a trailblazer in the study of how the brain manages

distractions and interruptions. Dr. Larry Rosen is a psychologist who has studied the “psychology of technology” as a pioneer in this field for more than thirty years. Our complementary perspectives focus on demonstrating why we fail to successfully navigate our modern technological ecosystem and how that has detrimentally affected our safety, cognition, education, workplace, and our relationships with family and friends. We enrich this discussion with our own research and scientific hypotheses, as well as views of other scholars in the field, to explain why our brains struggle to keep up with demands of communication and information.

We present our perspectives in three parts. In Part I, we will take you on a tour through new insights into why our “interference dilemma” exists in the first place and why it has become so relevant to us now. We describe how the very essence of what has evolved furthest in our brains to make us human—our ability to set high-level goals for ourselves—collides head-first with our brain’s fundamental limitations in cognitive control: attention, working memory, and goal management. This collision results in our extreme sensitivity to goal interference from both distractions by irrelevant information and interruptions by attempted multitasking. This noise degrades our perceptions, influences our language, hinders effective decision making, and derails our ability to capture and recall detailed memories of life events. The negative impact is even greater for those of us with undeveloped or impaired cognitive control, such as children, teens, and older adults as well as many clinical populations. We further discuss why we engage in high-interference-inducing behaviors from an evolutionary perspective, such that we are merely acting in an optimal manner to satisfy our innate drive as information-seeking creatures.

In Part II, we will share a careful assessment of our real-world behaviors and demonstrate how the collision described in Part I has been intensified by our constant immersion with the rich landscape of modern information technology. People do not sit and enjoy a meal with friends and family without checking their phones constantly. We no longer stand idle in waiting lines, immersed in thought or interacting with those next to us. Instead, we stare face down into virtual worlds beckoning us through our smartphones. We find ourselves dividing our limited attention across complex demands

that often deserve sustained, singular focus and deeper thought. We will share our views of why we behave in such a manner, even if we are aware of its detrimental effects. Building a new model inspired by *optimal foraging theory* we explain how our high-tech world perpetuates this behavior by offering us greater accessibility to feed our instinctive drive for information as well as influencing powerful internal factors, such as boredom and anxiety. We are most certainly *ancient brains in a high-tech world*.

Finally, in Part III we offer our perspectives on how we can change our brains to make them more resilient, as well as how we can change our behavior via strategies to allow us to thrive in all areas of our lives. We first explore the full landscape of potential approaches available to us—from the low-tech to the high-tech—that harness our brain's plasticity to strengthen our Distracted Mind. This in-depth examination includes traditional education, cognitive training, video games, pharmaceuticals, physical exercise, meditation, nature exposure, neurofeedback, and brain stimulation, illustrating how in these fascinating times the same technologies that aggravate the Distracted Mind can be flipped around to offer remediation. We then share advice on what we can do from a strategic perspective to modify our behavior, without abandoning modern technology, such that we minimize the negative consequences of having a Distracted Mind. Using the optimal foraging model introduced earlier in the book as a framework to approach behavioral change, all of the strategies we offer are practical and backed by solid science.

The Distracted Mind will enlighten you as to how and why our brains struggle to manage a constantly surging river of information in a world of unending interruptions and enticements to switch our focus. We extend this perspective to explore the consequences of this overload on our ability to function successfully in our personal lives, on the road, in classrooms, and in the workplace, and address why it is that we behave in this way. Critically, we provide solid, down-to-earth advice on what we need to do in order to survive and thrive in the information age.

Part I

COGNITION AND THE ESSENCE OF CONTROL

YOUR BRAIN IS an incredible information-processing system and the most complex structure known to humankind. The brain has allowed us to perform extraordinary feats from discovering general relativity to painting the Sistine Chapel, from building airplanes to composing symphonies. And yet, we still forget to pick up milk on the way home. How can this be?

In this first part of the book, we explain how the collision between our goals and our limited cognitive control abilities leads to interference and diminished performance. In chapter 1, we begin by discussing interference in detail: what it is, how it affects us, and why it seems to be getting worse. Here we propose that a model originally created to explain foraging behavior in animals can be adapted to understand our propensity for task switching. In chapter 2, we look at how the human brain has evolved to establish complex goals and implement them using a set of abilities known as cognitive control: attention, working memory, and goal management. Chapter 3 is a deep dive into the brain. The development of noninvasive technologies over the last couple decades has allowed us to peer into a functioning human brain, enabling us to much better understand brain processes and cognitive control. As impressive as these abilities are, they are also subject to fundamental limitations that have not changed all that much from our ancient ancestors. In chapter 4, we explore these limitations in our attention, working memory, and goal management. Finally, in chapter 5, we examine how these limitations are affected by age, clinical conditions, and even day-to-day changes in our internal state.

1 INTERFERENCE

WE HAVE COME to believe that the human brain is a master navigator of the river of information that rages steadily all around us. And yet we often feel challenged when trying to fulfill even fairly simple goals. This is the result of *interference*—both *distractions* from irrelevant information and *interruptions* by our attempts to simultaneously pursue multiple goals. Many of you may now be glancing accusingly at your mobile phone. But before we place any blame on this potential culprit, it is critical to understand that our sensitivity to interference, or what we will refer to throughout this book as “the Distracted Mind,” was not born out of modern technology. Rather, it is a fundamental vulnerability of our brain. Consider these three scenarios, which could just as easily have happened to you today as over a hundred years ago:

- You step into your kitchen and open the refrigerator (or icebox), and your mood sinks as you realize that you have absolutely no recollection of what it was you wanted to retrieve. How is this possible? Surely you can remember a single item for the several seconds it took you to arrive there. A bit of introspection and you realize that this was not the result of a pure “memory” glitch, but rather the result of interference—you were distracted from your goal by intrusive thoughts of an upcoming meeting.
- You sit at a meeting, staring at your colleague across the table in a crowded restaurant (or watering hole), struggling to follow her story. You can hear her just fine, but it seems that your brain keeps getting hijacked by the chatter of the room around you, even though you are desperately trying to ignore these distractions.

- You walk home from the meeting through an unfamiliar part of town, but instead of focusing on your route you keep thinking about your conversation; the next thing you know you have lost your way. Interruption generated by your own mind derailed you from successfully accomplishing your goal.

Despite our brain's inherent sensitivity to interference, it is undeniable that recent technological advances have made things more difficult for the Distracted Mind. Welcome to our new reality:

- You are at a meeting, and although an important new project is being discussed and the use of devices during meetings is seriously frowned upon, you sneak a peek at the mobile phone in your lap to check the status of an email you were expecting ... and while you are at it, you casually scan a few social media sites to catch up on your friends' latest activities.
- You are at the dinner table with your family, the television blaring in the background, and everyone has a phone sitting on the table that they constantly pick up, check the screen, tap a few times, and then put down face up so they don't miss incoming messages. This is followed by clumsy attempts to figure out what you missed in the conversation and reengage as best as possible.
- You are cruising along the highway at 60 mph. You feel that familiar buzz in your pocket—you got a text! You certainly know better, but you reach for your phone anyway, guiltily glancing over at the driver in the car next to you.
- Your child uses an iPad as part of a new school program to introduce technology into the classroom. Seems like a good idea until you get a call from your son's teacher who informs you that that he is not using it for the intended purpose; instead, he is constantly playing video games and downloading apps during class.
- You plop down at your desk with a heavy burden on your mind of an important assignment due by the end of the day. Despite the fact that high-level performance on this task is critical for your job evaluation, you find yourself constantly checking your email and Facebook. As the day goes by, each interruption sets off a chain reaction of communication that increases your chances of missing your deadline. You know you need to focus on your task, yet you continue down this doomed path.

So many technological innovations have enhanced our lives in countless ways, but they also threaten to overwhelm our brain's goal-directed

functioning with interference. This interference has a detrimental impact on our cognition and behavior in daily activities. It impacts every level of our thinking, from our perceptions, decision making, communication, emotional regulation, and our memories. This in turn translates into negative consequences on our safety, our education, and our ability to engage successfully and happily with family, friends, and colleagues. The magnitude of the impact is even greater for those of us with underdeveloped or impaired brains, such as children, older adults, and individuals suffering from neurological and psychiatric conditions. If we hope to successfully manage interference, we first must understand its nature.

WHAT IS GOAL INTERFERENCE?

“Interference” is a general term used to describe something that hinders, obstructs, impedes, or largely derails another process. When you pick up static on a radio station, you are detecting interference with the reception of radio waves that are relevant to you; this is also referred to as “noise.” The goal interference described in the above scenarios is in many ways not very different from radio noise. This type of interference has been the focus of extensive research by a diverse group of experts in fields as varied as psychology, neuroscience, education, advertising, marketing, and human factors; but it is not often presented as a unified construct, which is one of the main goals of this book.

Goal interference occurs when you reach a decision to accomplish a specific goal (e.g., retrieve something from the refrigerator, complete a work assignment, engage in a conversation, drive your car) and something takes place to hinder the successful completion of that goal. The interference can either be generated *internally*, presenting as thoughts within your mind, or generated *externally*, by sensory stimuli such as restaurant chatter, beeps, vibrations, or flashing visual displays (figure 1.1). Goal interference, originating from either your internal or external environments (often both), can occur in two distinct varieties—distractions and interruptions—based on your decision about how you manage the interference.¹

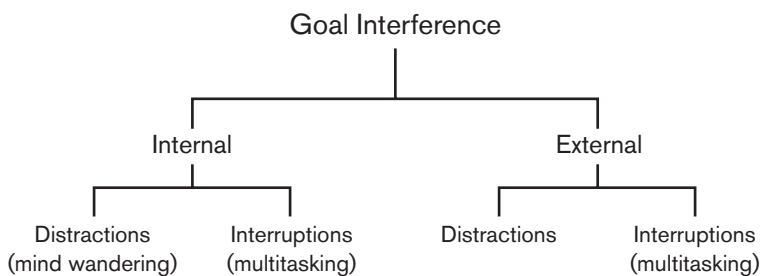


Figure 1.1

A conceptual framework of goal interference that can be generated both internally and externally, and can be elicited by both goal-irrelevant information (distractions) and multitasking (interruptions).

To understand these different types of goal interference, we find it helpful to temporarily set aside a discussion of the influence of technology and consider a scenario that has taken place for millennia—the act of sitting down with a friend to catch up on each other’s lives. This seems like a relatively straightforward goal. But, even without the presence of modern technology, four types of interference threaten to derail you from accomplishing this sort of goal: internal distraction, external distraction, internal interruption, and external interruption. Let’s dive in and discuss each of them.

Distractions are pieces of goal-irrelevant information that we either encounter in our external surroundings or generate internally within our own minds. When it comes to distractions, our intentions are very clear—we wish to ignore them, shut them out, suppress them, and carry on with attempting to accomplish our singular goal. Consider the following sort of very common situation:

You are engaged in that interesting conversation with your friend, but then your mind wanders against your will to something completely irrelevant to the conversation: “I can’t believe my boss didn’t notice how much I accomplished this week!”

This is an example of an internal distraction, also sometimes known as mind wandering. Mind wandering is frequently negative in content, as in this scenario.² Just as often, however, distractions are generated externally by

surrounding sights, sounds, and smells that are irrelevant to your goals, as in the following situation.

You are listening to your friend when you hear your name mentioned at a table nearby. Even though you already heard it before and are sure that they are not referring to you, hearing your own name captures your attention against your will and shifts your focus away from your goal.

And so, in a manner similar to what occurs when your mind wanders, information that is irrelevant to your goals can result in interference that we refer to as external distractions. Even if it is clear to you that external distractions will derail your conversation—and you are resolved to ignore them—they still often penetrate your mind and divert your attention away from your goals, thus diminishing your performance.

Interruptions are the other major source of goal interference. The difference from distractions is that interruptions happen when you make a decision to concurrently engage in more than one task at the same time, and even if you attempt to switch rapidly between them. Just like distractions, interruptions may be generated internally or externally. To appreciate an internally generated interruption, let's revisit the conversation you were having with your friend.

The conversation has become much less interesting to you. And so, you decide to fragment off a bit of your focus and direct it toward thinking about how your boss perceives your efforts at work, all the while attempting to maintain the conversation with your friend.

This act of voluntarily engaging in a concurrent, secondary internal task is an internally generated interruption. It generates interference by derailing your goal of having a meaningful conversation. Interruptions are also frequently generated externally.

Now while engaged in conversation with your friend, you overhear a fascinating conversation taking place nearby and make the decision to simultaneously eavesdrop as you continue your own conversation.

Interruptions such as these are often referred to as “multitasking,” defined as the act of attempting to engage simultaneously in two or more tasks that

have independent goals. The word “attempting” is used here because, as you will see later in the book, multitasking may be the behavior you decide to engage in, but when it comes to what actually occurs in your brain, the term “task switching” is a better description.

Interestingly, the actual content of goal interference can be the same for distractions and interruptions. In our example, thoughts of your boss’s impression of your work quality were the source of interference for both internal distraction and interruption, and an overheard conversation was the source of both external distraction and interruption. What distinguishes distractions from interruptions are your intentions about how you choose to manage them; either you attempt to ignore them and carry on with your original goal—distraction—or you engage in them as a simultaneous, secondary goal—interruption. Despite both of these being types of goal interference, different brain mechanisms underlie the performance impairment they generate, as we will discuss later.

WHY ARE WE SO SUSCEPTIBLE TO INTERFERENCE?

All complex systems are susceptible to interference, including the functioning of our cars, laptops, 747s, and the Hubble Telescope. The opportunity for interference to degrade any system’s performance seems to scale with its complexity. When it comes to the human brain, undeniably the most complex system in the known universe, it should thus come as no surprise that it is extremely sensitive to interference at many levels. Indeed, the reason why goal interference in particular is so prominent in our lives is the inherent complexity of our goals and the limitations we have in fulfilling them. Our ability to establish high-level goals is arguably the pinnacle of human brain evolution.³ Complex, interwoven, time-delayed, and often shared goals are what allow us humans to exert an unprecedented influence over how we interact with the world around us, navigating its multifaceted environments based on our decisions rather than reflexive responses to our surroundings. Our impressive goal-setting abilities have permitted the remarkable development of our cultures, communities, and societies and have enabled us to create complex human constructs, such as art, language, music, and technology.