CYBERPSYCHOLOGY AND THE BRAIN

Cyberpsychology is a relatively new discipline that is growing at an alarming rate. While a number of cyberpsychology-related journals and books have emerged, none directly address the neuroscience behind it. This book proposes a framework for integrating neuroscience and cyberpsychology for the study of social, cognitive, and affective processes and the neural systems that support them. A brain-based cyberpsychology can be understood as a branch of psychology that studies the neurocognitive, affective, and social aspects of humans interacting with technology, as well as the affective computing aspects of humans interacting with computational devices or systems. As such, a cyberpsychologist working from a brain-based cyberpsychological framework studies both the ways in which persons make use of devices and the neurocognitive processes, motivations, intentions, behavioral outcomes, and effects of online and offline use of technology. *Cyberpsychology and the Brain* brings researchers into the vanguard of cyberpsychology and brain research.

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CYBERPSYCHOLOGY AND THE BRAIN

The Interaction of Neuroscience and Affective Computing

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I dedicate this book to a monkey, a bearcat, a bugaboo, and a beagle. Together we make a family.

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Preface

While cyberpsychology is a relatively new discipline, it is one that is growing at an alarming rate. Perhaps this is due to the fact that humans are witnessing a time of rapid progress in an increasingly connected world. As a result, we have seen the emergence of a number of cyberpsychology-related societies, conferences, journals, and academic-level texts. Interestingly, none of these academic journals or books on cyberpsychology directly addresses the rapid progress in neuroscience. There are now dozens of laboratories around the world that have converged to investigate neurocognitive, affective, and social questions. While there is a great deal of work in cyberpsychology that deals with neural correlates of persons interacting with technology and neuroscientific investigations of cyberpsychology issues, there is no text that pulls together this material for cyberpsychologists. This book is a first attempt at bringing together this information for researchers and students in cyberpsychology.

To encourage the inclusion of brain science research in the cyberpsychology domain, this book proposes a framework for integrating neuroscience and cyberpsychology for the study of social, cognitive, and affective processes and the neural systems that support them. Given these emphases, a brain-based cyberpsychology can be understood as a branch of psychology that studies (1) the neurocognitive, affective, and social aspects of humans interacting with technology and (2) affective computing aspects of humans interacting with devices/systems that incorporate computation. As such, a cyberpsychologist working from a brain-based cyberpsychological framework studies both the ways in which persons make use of devices and the neurocognitive processes, motivations, intentions, behavioral outcomes, and effects of online and offline use of technology. Research in a brain-based cyberpsychology framework ranges from studies with offline platforms (using desktop computers, word processors, virtual/augmented reality, gaming consoles, and statistics packages), to online Internet use (how we engage in online banking, shopping, dating, and

gaming), to mobile phones. These studies emphasize the study of neurocognitive, affective, and social processing behaviors in relation to the ways in which persons use and communicate via technological devices. Cyberpsychologists view these devices as tools that either facilitate or impede human interaction and communication.

Cyberpsychology has a lot to offer human neuroscience research. Specifically, there is increasing acknowledgment among social, cognitive, and affective neuroscientists that there is a need to move beyond the static stimulus presentations found in their investigations of human neurocognition. While many of the pioneering paradigms in the human neurosciences reflected a noteworthy emphasis on laboratory control and experiments that involve participants observing static stimuli that are devoid of interactions, there are increasing questions about whether knowledge gained using these static stimuli will generalize to the social, cognitive, and affective processes found in everyday activities. Cyberpsychologists can aid these neuroscientists by introducing them to the more ecologically valid scenarios found in cyberpsychology simulations (e.g., virtual and augmented reality).

In addition to the positive impact that cyberpsychology stimuli and platforms can have on the human neurosciences, there is a great deal that cyberpsychology can gain from the cognitive, affective, and social neurosciences. While neuroscientific research is highlighted throughout this book, many of the examples provided reflect assessments of behavioral performance. Although it can be challenging to operationalize the extent to which a stimulus approximates activities of daily living, this book gives examples of stimuli and virtual environment–based contexts that span the implied continuum. The studies reviewed in this book are not meant to be exhaustive. Instead this review focuses on cyberpsychology research that highlights the ways in which persons respond to clinical, affective, and social stimuli in simulations that approximate real-world activities and interactions.

The cognitive, affective, and social neurosciences can support cyberpsychology by offering supplementary assessments of the assumptions that cyberpsychologists make regarding neurocognitive and affective aspects of interacting with technologies. In turn, lessons learned from cyberpsychology can aide efforts to formulate and specify neuroscientific models of humans interacting with technology. Increasingly, brain researchers have become interested in identifying neuronal networks involved in Internet use, neuropsychological aspects of virtual environments, ethical decision-making, and social interactions using virtual humans. Cyberpsychology

approaches can be of use to these efforts by offering reliable and empirically valid approaches to human–computer interactions that affective and social neuroscientists are beginning to use.

Organization of This Book

To provide a framework for a brain-based approach to cyberpsychology, this book is divided into five parts.

Part I provides an introduction to the framework for a brain-based cyberpsychology. Following the opening chapter that introduces components of this framework, Chapter 2 provides the reader with a primer on brain anatomy and terminology. While some areas are briefly discussed for the sake of completeness and continuity, other areas, such as large-scale brain networks and frontal-subcortical circuits, receive greater attention. Instead of presenting a comprehensive account of these structures and functions, Chapter 2 aims to present a foundation for the conceptualization of the material covered in the chapters that follow. Chapter 3 offers a synopsis of psychophysiological metrics and quantification parameters describing the assessment of particular physiological structures and systems.

Part II contains a discussion of the impact of various media on the brain. In Chapter 4, there is a discussion of the impact of the Internet on the user's brain. In addition to the impact of the Internet on brain anatomy and function, this chapter introduces an "extended mind" theory, in which cognitive processes are understood as going beyond wetware (i.e., brain) to software and hardware used by the brain. This perspective allows for an understanding of human cognition as processed in a system coupled with technology. Chapter 5 looks specifically at the relations between Facebook and the socially networked brain. It attempts to answer questions related to why we are so motivated to connect with others online. The brain's reward network is likely activated when using Facebook (e.g., user receives a "like" to their posted content on a Facebook page). This chapter also explores Robin Dunbar's social brain hypothesis in the age of the Internet. According to Dunbar, human intelligence evolved as a means of surviving and reproducing in complex social groups. In the 1990s Dunbar proposed a neurocognitive limit to the number of people a person can have in their social network. Recent studies of humans afford evidence of quantitative relations between social group size and brain regions that perform an important part in social cognition. These findings reflect work done in offline social networks. This chapter explores whether the seemingly

ubiquitous and perpetual use of social media challenges the continued relevance of Dunbar's number. In Chapter 6 there is a discussion of media multitasking and its impact on the brain. With the ubiquity of media technologies, people increasingly add greater amounts of media content into the same amount of time. This is accomplished through the use of numerous media types concurrently, in this manner taking part in "media multitasking." There are some who have hypothesized that the increased prevalence of media multitasking is problematic, because frequent engagement in media multitasking may have negative impact on cognitive control processes. Others have argued that media multitaskers do not attend to the information that is relevant to one task at a time. Instead, heavy media multitaskers have a cognitive style that includes a greater breadth of attention. This chapter discusses these issues. Finally, Chapter 7 delves into issues of cyber addictions. There is a growing body of cyberpsychology research into the relations between online media use and compulsive behaviors, self-regulation, impulse control, and substance abuse. This chapter explores the impact of excessive Internet on brain anatomy and functioning.

In Part III, the book turns a spotlight on the ways in which cyberpsychology can enhance research done in human neuroscience. This part starts with Chapter 8, wherein the reader is presented with a discussion of the ways in which simulation technologies found in cyberpsychology can offer ecologically valid alternatives to the static stimuli found in the affective (Chapter 9), social (Chapter 10), and clinical (Chapter 11) neurosciences. In Chapter 9 the aim is to provide a framework for ecologically valid cyberpsychology investigations into the cognitive and affective aspects of everyday lived experience. Herein, affective computing is introduced as a cyberpsychology approach that can aid and benefit from affective neuroscience. That said, there is a realization that much of our everyday lives involves interactions with others. As such, Chapter 10 presents a social neuroscience–informed approach to ecological validity. Finally, in Chapter 11, there is the issue of moving beyond cyberpsychology paradigms with healthy controls into the realm of clinical neuroscience. Advances in the clinical neurosciences have greatly enhanced our understanding of the brain's cognitive and affective processing in neurologic and psychiatric disorders. The noteworthy developments made at the end of the twentieth century in understanding the genetic and neural correlates of many diseases affecting the brain are important for a brain-based cyberpsychology. Cyberpsychologists interested in clinical neuroscience research and practice should be aware of both the contributions of clinical neuroscience to

cyberpsychology and the potential that cyberpsychology research and practices have for the clinical neurosciences.

Part IV presents an introduction to psychophysiological computing in cyberpsychology (Chapter 12), the cyberpsychology of videogames (Chapter 13), and NeuroIS (Chapter 14). In Chapter 12, psychophysiological assessment is presented as a way to enhance experimental control in virtual environments that are being used for cyberpsychology applications. Psychophysiological metrics provide an excellent measure of presence and autonomic arousal. Hence, they provide a profile of the user state and a validation of the impact of the virtual environment on the user. In Chapter 13, there is a review of the growing body of literature that focuses on assessment of action videogame player cognition. Furthermore, there is a discussion of the neural correlates underpinning the enhanced cognitive processing favoring videogamers. Chapter 14 closes this section with a review of the development of NeuroIS and its relation to cybersecurity. Information systems research is a recent area to incorporate the behavioral neuroscience literature. In the same way that other areas of cyberpsychology are drawing from recent advances in brain and behavioral neurosciences, information systems researchers are looking at the complex interplay between information technology and neuroeconomics, information processing, and social neuroscience. Information systems researchers have started to investigate the potential of the human neurosciences (e.g., social, cognitive, and affective neurosciences) for information sciences research.

Finally, Part V concludes the book with a discussion of scientific and pragmatic challenges for bridging cyberpsychology and neuroscience. A brain-based cyberpsychology represents an emerging effort to integrate neuroscience methods (e.g., neuroimaging) with cyberpsychological methods to address issues of assessment and training. This chapter presents potential concerns about connecting neuroscience to cyberpsychology. The chapter first articulates some potential concerns and then reinterprets them as potential opportunities. Throughout the book there has been a presentation of instances in which neuroscience findings and methods have been found to be relevant for cyberpsychology. The goal of this book is to offer cyberpsychologists a window into contemporary neuroscience to prepare them to think more specifically about the prospects of a brain-based cyberpsychology.

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I wish to acknowledge the significant people who inspired the writing of this book.

Collaborations with my colleagues at the University of Southern California and the University of North Texas have inspired a number of ideas found in this book. I spent a number of years as a research scientist and faculty member at the University of Southern California's Institute for Creative Technologies. During that time I had the great fortune of working with scholars who were passionate about cyberpsychology. In particular, Patrick Kenny and I spent countless hours in Venice Beach discussing the potential impacts of integrating neuroscience into cyberpsychology theory and research praxes. At the University of North Texas, I have benefited from collaborative work and conversations with Ian Parberry in Computer Science and Lin Lin in Learning Technologies.

I should also mention that much of my interest in cyberpsychology was aided by studying the works of Umberto Eco, Jorge Luis Borges, Ludwig Wittgenstein, David Chalmers, and Andy Clark. First, Eco's work on semiotics (e.g., semiological guerrilla) has taught me how to travel with a salmon in my pocket, to consider the platypus using Kantian categories, and to appreciate the aesthetics of chaosmos. My first artificially intelligent cognitive architecture was named Abulafia in tribute to the computer system in Eco's *Foucault's Pendulum*. I am also indebted to Jorge Luis Borges for his discussions of libraries, labyrinths, time, and infinity. Next, there is Ludwig Wittgenstein's brilliant early work in the *Tractatus Logico-Philosophicus*, and his later work in the *Philosophical Investigations*, wherein he discarded much of what he argued in the *Tractatus*! Finally, the work of Andy Clark and David Chalmers on extended cognition has provided a framework for extending cognitive processes via an active externalism that has helped me conceptualize technology and neurobiology in terms of a "coupled system."

There are also a number of students and postdoctoral fellows who both inspired me and diligently assisted with research for the manuscript. Two graduate students stand out as exemplars of why I "do what I do" each day: Christopher Courtney from the University of Southern California and Timothy McMahan from the University of North Texas.

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