PART I

Fundamentals

One

Introduction

Importance, Implications, and Historical Perspectives

Scenario 1

Mary heard the familiar sound of a buddy coming online in iChat. She looked to the upper left of her screen and saw it was her friend Molly. She clicked on Molly; a pop-up window opened; and she typed, "Hey, what's up?" A few seconds later she read, "Have an intro psyc test tomorrow . . . studying the notes online. How about you?" Mary typed, "Not much, trying to write a paper and looking for refs. Doing a little shopping on the side." She glanced at her "shopping cart," which held a t-shirt and coffee mug she was getting for her brother's birthday. Just then, both of them noticed that their friend Martha came online, so they opened a multichat window. Each girl had her own icon. Mary had a picture of a female vocalist, Molly was a kitten, and Martha had a miniature picture of herself with a big grin. As it turned out, Martha was checking the movie listings and hoping to get the other two girls to go with her to a movie. Martha enticed them with a movie they had all been talking about seeing together. Mary typed, "OK, I'm done with shopping and my paper isn't due until next Monday. I'm ready." Mary keyed in, "Hey, it's a psyc test, I can wing it. I'm in. Let's go." Mary, Martha, and Molly got up and left the dorm room where they had been sitting together for the past hour, each at her own computer.

Scenario 2

Dr. Mike J.: *Mark can you move that scope just a little to the left? OK, I see it. Yes, there it is. Apply the clamp just to the left on the artery. Perfect. OK, let's get a biopsy on that tissue.*

Dr. Mark M.: OK, Mike, I've got the biopsy. Let me just scan it in. Melvin, what's your read on it?
Dr. Melvin N.: Just a second, I am running a full DNA sequence on it. So, how was the fishing trip, Mark? Catch any trout?
Dr. Mark M.: Great. Would have got my limit if it hadn't been for this emergency. How was your golf game, Mike?
Dr. Mike J.: Terrible, I was glad to get out of the game.
Dr. Melvin N.: The analysis just finished. Take a look. Everything is OK.
Dr. Mike J.: Wonderful! Mark, you want to close him up and give his wife the good news. Wish I could join you fishing out there in Wyoming. Got to go to a faculty meeting here at Johns Hopkins. Melvin, thanks for quick analysis from DNAtronics, UK!

Overview

Since the beginning of the computer revolution, a number of us have been trying to convince our colleagues in psychology about the importance of human–computer interaction (HCI). Some got it, but many didn't, and some still don't. Many psychologists view computer technology as a powerful research tool, but stick to "basic psychology" for their research. The study of human–computer interaction is "too applied" to be of central importance in psychology. Yet, many of our colleagues study the psychology of sports, the psychology of women, and the psychology of sex. Although not downplaying the importance of these, it can be asserted that we spend more time watching our computer screens than watching or playing sports; although men may be from Mars and women are from Venus,[1] computers are taking over the Earth; and although not as stimulating or reproductive, we have more interaction with our computers than with our partners (hence, the term "computer widows").

Meanwhile, we have quickly transitioned from a generation of computer illiterate students to a generation of computer savvy professionals. Thirty years ago, most computers were locked away behind heavy security doors, and only computer technicians had access to them. Today, personal computers are a common retail item. Access to the Internet is an essential service. We spend so much time interacting with computers, e-mail, and instant messaging that we may forget that we are communicating with people in the same room, as in Scenario 1. Nearly every job entails the use of computers on a constant basis. Every cash register, filling station pump, and auto parts lookup station is a computer. Every bank, hospital, airline, and social agency runs off networked computers and databases. Scenario 2 illustrates their use

[1] A reference to the book by Gray (1993).

in telemedicine. Computers are ubiquitous and pervasive. They are hidden behind the dashboards of our cars; they are at the other end of telephone calls to credit card companies; and they are the brains of automated teller machines (ATMs), cell phones, personal digital assistants (PDAs), digital cameras, DVD players, and digital cable boxes. There are no computer-free days. There is no escaping daily time with computers. Consequently, we have to come to grips with their presence in our psychological reality.

Living in a computerized, automated, digital world is different than living in the manual, analog world of the past. What we see and hear today is mediated by computer displays. How we take actions to do things is channeled through computer input devices. Where and how we store and organize things is determined by computer storage media and data structures. How we think and solve problems is either limited or augmented by computer functionality. Who we are, our goals and aspirations, and even our sense of self are altered by the electronic environment with digital communications, digital images, artificial intelligence (AI), icons, screen names, and passwords.

Psychology as a science and a discipline must do more than merely acknowledge that we live in a digital environment with computers and automation. It must do more than add a footnote, chapter, or illustration to current texts while perpetuating theories developed in the pre-digital world. Instead, it must rethink its basic theories in every area – from sensory and perception to social and clinical.[2] Fortunately, this is occurring in some areas. Cognitive science and neuroscience were founded in the digital age, and human factors psychology has embraced the interaction with computers, but a number of areas have fallen behind. Rather than make too much of this now, we instead develop and push these areas forward as we go through the successive chapters of this book. Finally, we try to cover the full range of psychology. To do this, we use as our guide the list of topics and chapters in a typical Introduction to Psychology course.

Psychology or Computer Science: Two Paths, One Journey

In high school, I was interested in science and electronics. So, naturally, I should have majored in science or engineering in college; yet, when I entered Southern Methodist University as a freshman, I decided to major in psychology. My reasoning was that what the world needed was not a better transistor radio or a new formula for plastics, but solutions to the deeper problems of the human mind. I did, however, take one introductory course in computer science, Computers and Society, in which the instructor taught us how to program in a language called PL/1 and covered a wide range of social issues. Many of these issues are still central today, such as computer fraud, AI,

[2] I am not as extreme as to say that basic theories need to be discarded or reinvented. I am only saying that we need to think about them in light of the computer revolution.

privacy, and secrecy. Although tempted to change majors, I stayed in experimental psychology with a parallel interest in computers and mathematics. Through my graduate studies at the University of Iowa and postgraduate work at the University of California at San Diego, I looked for avenues that connected psychology and computer science. I focused on mathematical psychology and computer simulations of human judgment and decision making. We were looking for ways of modeling human behavior using equations and computer programs. Along with many others in experimental psychology, I used computers to plan, control, and analyze experiments on learning, memory, judgment, and decision making, using minicomputers such as the PDP-12 and mainframe computers such as the IBM 360.

As it turned out, over the years there were many avenues between psychology and computer science. Psychology used computers as research tools and to model human behavior. The Society for Computers in Psychology (SCiP) was and remains a lively forum for psychologists to share ideas and software.

Computer scientists also had several reasons for being interested in psychology. First, those who were developing ideas in AI were interested in studying human problem solving as a starting point for heuristics and strategies, for common sense and expert knowledge about the world, and sometimes as a last resort after they had tried everything else they could think of. Second, as computers started to be used by the masses, those who were programming the computer interface needed to know how people interacted with the computer and why so many "human" errors were occurring. This group continues to study the human–computer interface in order to make it more intuitive, easy to use, error free, and require little or no training.

Moreover, there has been a realization in psychology that the world has changed and that there are significant forces on psychological and sociological processes from the digital environment. This has given birth to what is now called "cyberpsychology." Some of this is "pop" psychology, but much of it is a serious study of the consequences for humans using computers and the Internet.

This book attempts to cover the following four areas of overlap: 1) the use of computers as a research tool for studying psychological processes, 2) human–computer interaction, 3) AI, and 4) cyberpsychology.

Finally, we find two groups of people on the path between psychology and computer science: those interested in psychology but looking in the direction of computers for answers, and those interested in computers but looking in the direction of psychology for answers.

What Is the Psychology of Human–Computer Interaction?

As psychologists, we are interested in studying human behavior. Why do people act the way that they do? How can we explain and predict behavior?

How do people learn, modify, and correct behavior? We are also interested in subjective feelings, perceptions, moods, and emotions. We want to understand how people think, solve problems, and make decisions. All of this has to do with people in the environment interacting with physical stimuli and with one another. As computers become a greater part of that environment, psychologists will have to come to grips with their impact.

Computer scientists are interested in the theory of computing, the design and construction of computers, the development of computer programs and operating systems (OSs), and their application to real-world systems such as personal computers, the Internet, and a variety of software applications in business, government, education, and personal use. Ultimately, computer scientists have to deal with the "user" (i.e., the person interacting with the system) at some point. To know what to display on the screen and how to interpret user input, they have to ask, "What is this person thinking?" Computer scientists working with the human–computer interface, like psychologists, want to explain and predict user behavior. They want to know how people learn to use computers, how they modify their input, and how they identify and correct their mistakes. They are also interested in subjective impressions. What is the attitude of the user? Is the user frustrated, satisfied, or anxious about the interaction? Finally, how do users solve problems, search for information, and make decisions? Today, it seems that most computer scientists working with the human–computer interface and most designers of interactive technologies are doing the work of psychologists.

Thus, the psychology of the human–computer interface is the study of thinking, behavior, and attitudes of the person or groups of people using the computer or computer system. In Chapter 3, we develop this in greater detail by discussing a number of theories and models of the human–computer interface.

What Is Cyberpsychology?

Is "cyberpsychology" just another techie buzzword, or is there really something behind it? The prefix "cyber" comes from the word "cybernetics," the study of the operation of control and communication systems, and comes from the Greek word for steersman. Cybernetics was popularized by Norbert Wiener (1948/1961) in his book by the same name, *Cybernetics*. In it, Wiener discusses the primary ideas of feedback loops, homeostasis, and the hierarchical structure of machines.

The second part of cyberpsychology, "psychology," refers to the study of human behavior and cognitive processes. When we put the two parts together to create the term cyberpsychology, we engender a unique synergistic combination. Why? Because we, as humans, are inherently involved in control and communication. When these are mediated by machines, new factors and forces enter in that enhance and extend the purposes and intentions of the individual human mind and the collective purposes of communities of minds.

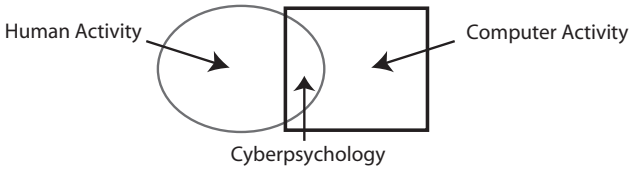

Figure 1.1. Cyberpsychology as the intersection of human and computer activity.

The study of cyberpsychology involves all aspects of human behavior and thought. One could easily pick up an introduction to psychology textbook and use the table of contents as the collection and the organization of topics. In fact, that is my plan for this book. We may talk about everything from the biological bases of behavior, sensation and perception, learning and motivation, thinking and problem solving, social processes, and developmental stages, to clinical and counseling psychology and psychotherapy! The difference is that in approaching each topic, we explore the avenues of contact between psychology and the emerging world of computers.

On the computer side, we talk about hardware and software, personal computers and central servers, OSs and human–computer interfaces, local area networks (LANs) and the World Wide Web (WWW), programming and debugging, multimedia and hypermedia, AI and software agents, and so on.

Cyberpsychology is not a course on how to use computers. In a sense, it transcends the "how-to" level to a metalevel in which we are interested in the "how-about" humans using computers. Most of the discussion is about others using computers rather than us. This is not to downplay experiential learning, but only to put it in its proper place. Computers, computer science, and technology are important. However, they do not supply the main content or the necessary organization of cyberpsychology. Instead, they provide the context in which we focus on psychological processes.

Cyberpsychology as a study is daunting. On one side, we have psychology where despite more than 100 years of study and research, we still know so little about the human mind. On the other side, we have computers, where technology is complex and changing rapidly. How can we cope intellectually between two such unknowns with one foot in psychology and the other in computer science? The good news is that instead of there being a void of confusion between the two, there are a number of commonalities, links, and analogues that turn it into an intellectual playground for ideas and theories and a powerful laboratory for exploring and testing these ideas.

In sum, cyberpsychology is the study of the impact of computers, technology, and virtual environments on the psychology of individuals and groups.

Although human–computer interaction refers more to an interface, cyberpsychology includes more of an overlap of space. It is the study of things that pertain to both the lives of humans and the activities of computers. As we go through the topics of this book, we explore what is in the overlap.

Figure 1.1 shows a diagram of the areas covered by human activity and computer activity. Over time, the area covered by computer activity has

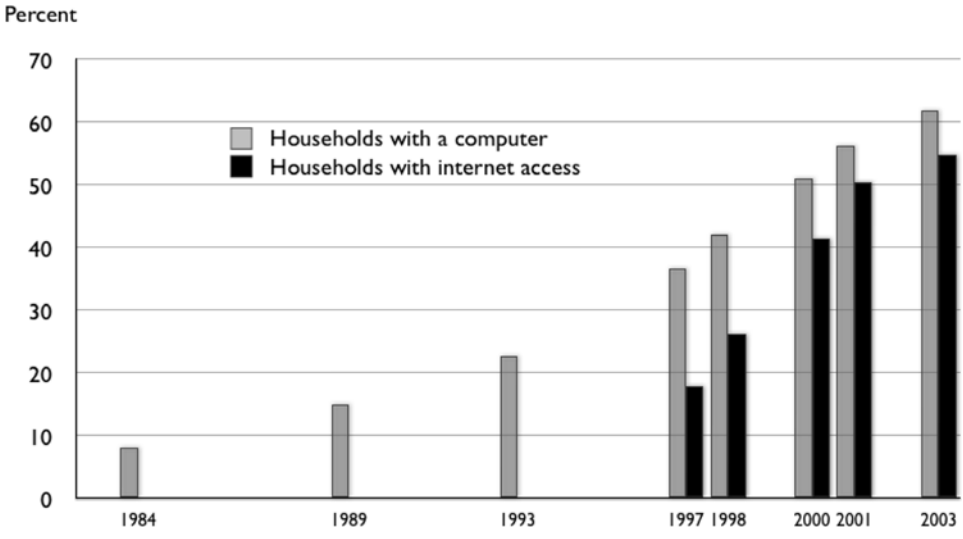

Figure 1.2. Households with a computer and Internet access from 1984 to 2003. (From Day, Janus, & Davis, 2005.)

dramatically increased, whereas the size of the area covered by human behavior has remained relatively the same. But as the area covered by computer activity has increased, the overlap has increased with it.

Impact and Importance of Cyberpsychology and the Human–Computer Interface

The break point in penetration of computers, the Internet, and related technologies is the beginning of the twenty-first century. It was roughly around the turn of the millennium that we in the United States broke the 50 percent mark in Internet use (Figure 1.2), personal computer use, and cell phone use. Some countries were ahead, and many have followed, but overall more than 50 percent of the populations of most industrialized countries now spend significant amounts of time interacting with computers and the Internet. Our perception goes beyond the objects and images in our natural environment, and now includes the graphics and images on the computer screen. When students look for information, more than 50 percent of them will go to the Internet rather than to books and library reference materials. The sphere of activities of computers has grown drastically over the past decades and engulfed larger amounts of human activity, as graphed in Figure 1.3. What is it that fills these areas of overlap between humans and computers? In the early years, it was primarily computer programming, database management, and mathematical and statistical computing. The overlap was limited to a select few computer programmers and analysts, and it was not much of an interface with teletypewriters and line printers. When the personal computer was introduced in the early 1980s, many more people

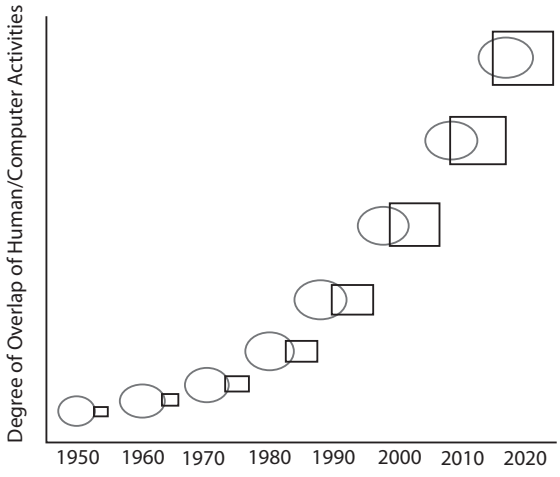

Figure 1.3. The increasing overlap of human activities (ovals) *and computer activities* (rectangles).

and activities were drawn into the overlap. With the introduction of word processors, more people composed and edited online rather than using paper and pencil or typewriters. Increasingly more of our conscious moments are spent in front of the computer, interacting with the mouse and keyboard. With personal management applications, people started to use electronic calendars, address books, notebooks, and planners. Our cell phones and PDAs are ever with us. Our entertainment centers, kitchens, and cars are filled with computer interfaces of one type or another. At the workplace, we have seen a mass conversion to digital devices and databases for secretaries, accountants, lawyers, librarians, and so on. Nearly every profession has been computerized.

In fact, the overlap has been so encompassing, pervasive, and ubiquitous that in just a few years we have taken it for granted. Now that we live in the age of computers, we must consider ourselves in light of the new environment with all of its enabling powers, all of its stresses, and all of its limitations. We must explore the overlap between human activity and computer activity. To do this, we need to understand things from both the perspective of psychology and the development of computers.

A Brief History of Psychology

Modern beginnings of psychology are credited to a number of influential scientists who pioneered theory and experimental research on behavior and the mind. Among them are Wilhelm Wundt, John Watson, Max Wertheimer, William James, and Sigmund Freud. Extensive histories can be found in other texts (Schultz & Schultz, 2004), but a brief history and a listing of a few names is given here as a review to set the perspective of what modern psychology

Figure 1.4. Wilhelm Wundt (1832–1920).

is founded on and to relate historical forces to current and future directions.

The origins of psychology come from different countries, laboratories, and perspectives. Its origins are so diverse that it is amazing that it coalesced into one discipline.

Wilhelm Wundt

Wilhelm Wundt (1832–1920) (Figure 1.4) is credited as being the "world's first psychologist." In 1874, he wrote the first textbook having to do with the field of psychology and conscious experience. In 1879, he established the first institute for experimental psychology at the University of Leipzig in Leipzig, Germany. Wundt used the method of introspection to study conscious processes. Observers were trained on how to report the contents of their own immediate states of consciousness (Humphrey, 1963). The purpose of the research was to determine the components of the conscious mind. He emphasized the elements of sensory, perceptual, and response processes.

Wundt used the person as the observer of his or her own impressions, thoughts, and behavior, an important concept in current psychology and in research on human–computer interaction. He conceived of the idea that elemental components of consciousness combine to form experiences that are more complex. Consequently, the first thing that researchers needed to do was to identify these components. This idea was later termed "structuralism" by Edward Titchner (1867–1927), one of Wundt's students who popularized the idea in America. Structuralism is an important concept for understanding how models of human–computer interaction are constructed today.

Wundt could also be called the "father of psychology" because between 1876 and 1919 he had more than 100 students who obtained doctoral degrees under his supervision (Fernberger, 1933; Tinker, 1932). A number of these