CHAPTER 1

The Science of Mobile Phone Behavior

Outline

1. Surprising Responses

One afternoon in 2015, I received an email inviting me to give a talk to a group of graduate students about mobile phone behavior. This was the very first time I had received such an invitation to talk about mobile phone behavior. Since this is my current research focus, I accepted the invitation with great pleasure. In preparing for this talk, I found that I knew little about how much my audience would know about mobile phone behavior.

Thus, I started my talk by first asking participants whether they had mobile phones and whether they used them daily. Everyone immediately raised their hands, indicating that each of them had a mobile phone and used it daily. Then I asked them to quickly write down their initial thoughts about a few brief questions so that I could learn their initial knowledge about mobile phone behavior, adjust my speech plan based on their knowledge, and warm them up for my talk on mobile phone behavior.

The talk went well and we had an interesting discussion about mobile phone behavior research. After the talk, I read their responses again and summarized them as follows: (1) When they were asked to quickly write down two key features of mobile phones, the majority of them indicated calling and texting. (2) When they were asked to quickly list two to three examples of mobile phone behavior, the majority of them listed sending text messages, looking up emails, and using Facebook. (3) When they were asked to estimate how many journal articles have been published on mobile phone behavior, the majority of them came up with a number ranging from 6 to 500 with an average of 173.

These responses were both interesting and surprising to me for several reasons. First, although I have been studying mobile phone behavior for several years and at the time of my talk had just finished editing the *Encyclopedia of Mobile Phone Behavior*[1] a few weeks prior, this was the first time I was able to explicitly see what people's *intuitive* knowledge about mobile phone behavior actually looked like. Obviously, these were very quick and informal responses from a group of graduate students. However, these quick and informal responses delivered authentic and interesting information: how much ordinary people may intuitively know about mobile phones, mobile behavior, and mobile behavior research.

Second, although we all know that many people have their own mobile phones and they use their mobile phones every day, looking at these responses, I was quite surprised to see how *limited* the knowledge was that some ordinary people had about their mobile phones and their mobile phone behavior. They tended to substantially oversimplify the complexity of mobile phone behavior. As we will first discuss in this introduction chapter and throughout this book later on, modern mobile phones, mobile phone behavior, and mobile phone behavior research are much more complex than we thought. After the talk, I had several more opportunities to communicate with multiple institutions, groups, and individuals

[1] Yan, Z. (ed.). (2015). *Encyclopedia of Mobile Phone Behavior*. Hershey, PA: IGI Global.

informally about their intuitive knowledge about mobile phone behavior. The results remained quite similar: there is substantial oversimplification of the complexity of mobile phone behavior, despite the diverse backgrounds, needs, and knowledge that people have. This eventually became the primary motivation, central theme, and major goal of writing this book: to describe, analyze, synthesize, and explain the complexity of mobile phone behavior that is related to a pocket-sized mobile phone.

Third, now we might wonder *why* some people tend to oversimplify the complexity of mobile phone behavior. There could be different theories and speculations to explain this phenomenon. Based on the Nobel Laureate Daniel Kahneman's intuitive judgement theory:[2] (1) people think with two systems – intuitive thinking (System 1) and rational thinking (System 2); (2) intuitive thinking is limited due to various cognitive heuristics and biases; and (3) people tend to think intuitively in their daily lives often, but can think rationally only after making extra efforts or improving existing knowledge. In the context of mobile phone behavior, people may develop their intuitive thinking based on their daily use of mobile phones. However, their intuitive thinking about mobile phone behavior is limited due to various cognitive biases. Effortful learning and training is needed to develop rational thinking about mobile phone behavior in order to develop an understanding and appreciation of its unusual complexity. Thus, in this book, we will use the concepts of intuitive thinking (System 1) and rational thinking (System 2) as the main conceptual framework to analyze mobile phone behavior.

In the text that follows in this introductory chapter, we will briefly discuss some basic knowledge about mobile phones, mobile phone behavior, and mobile phone behavior research, and provide an overview of the book, including two primary goals to achieve after reading the book. This is to set the stage for further in-depth discussions of various topics in the entire book to reveal the complexity of mobile phone behavior.

2. Mobile Phones

In 490 BC, Pheidippides, a Greek professional courier, ran over 42 kilometers from the battlefield of Marathon to Athens to deliver a message of the Greek victory over Persia. At the end of his running, he said: "Joy to you, we've won!" Right after that, he collapsed and died.

[2] Kahneman, D. (2011). *Thinking, Fast and Slow*. New York: Farrar, Straus and Giroux.

In 1876, 2,366 years later, Alexander Graham Bell, an American inventor and then a professor of Vocal Physiology and Elocution at Boston University, sat in his laboratory and made the first successful telephone call to his research associate, Thomas Watson, and said: "Mr. Watson, come here, I want to see you." Since then, humans have used telephones to deliver voice messages across a long distance effectively and efficiently, rather than having someone run a long distance to deliver a message.

In 1973, almost 100 years later, Martin Cooper, another American inventor and then the head of Motorola's communications systems division, stood on the Sixth Avenue of Manhattan, New York, and made the first mobile phone call in public to Joel Engel, then the head of research at AT&T's Bell Labs, and said: "Joel, this is Marty. I'm calling you from a cell phone, a real handheld portable cell phone." After that, only forty-two years later, worldwide mobile phone subscriptions had grown to 7.1 billion, with a penetration rate of 96.8 per cent.[3]

The mobile phone held in the right hand of Martin Cooper was DynaTAC, one of the earliest classic mobile phones. Nowadays, mobile phones have remarkably wide variations. We hear various names, such as basic phones, feature phones, smartphones, cellular phones, cell phones, VoIP phones, satellite phones, or app phones. These names represent various features of mobile phones and can generally be used interchangeably. We see different brands on the market, such as Nokia 3310, Moto 360, iPhone 6, BlackBerry Passport, Samsung Galaxy, or Xiaomi Mi4. Each is made by different companies, such as Samsung, Nokia, Apple, LG, ZTE, and Huawei. We have mobile phones connecting with different cellular networks (e.g., 1G, 2G, 3G, 4G) or Wi-Fi networks (e.g., regular station-based Wi-Fi, campus-wide Wi-Fi, city-wide Wi-Fi, ad hoc Wi-Fi). We know millions of apps from the Apple App Store, Google Play, Windows Phone Store, or BlackBerry App World to perform unlimited specific functions, such as emailing, maintaining a calendar, looking up stock information, weather, and news, as well as apps for health care, finance, gaming, reading, cooking, banking, fitness, navigation, travel, task management, getting a taxi, and almost any kind of app we can imagine. To know what mobile phones are and what basic features mobile phones have, we should examine mobile phones at different stages of the mobile phone history and understand the similarities and differences between classic mobile phones and modern mobile phones.

[3] See www.itu.int/net/pressoffice/press_releases/2015/17.aspx#.V_j1rcm2LeY.

2.1 Classic Mobile Phones

Although such a wide variety of mobile phones exist, each and every classic mobile phone, frequently called basic phones, such as DynaTAC, Nokia 3310, and Moto 300, share two basic features.

The first feature can simply be called *phone* – the second part of the term *mobile phone*. That is, a mobile phone must have a function of communication, either voice-based like a traditional telephone or text-based like a traditional telegraph. In this regard, mobile phones are essentially a technology of communication.

The second feature can be called *mobile* – the other part of the term *mobile phone*. Mobile generally means that a mobile phone needs to be movable so that people can carry it with them and use it freely in a large area. This feature of mobility requires at least four elements: (1) it must be able to conveniently move with users themselves rather than with other moving objects such as a police car or an airplane; (2) it must be small and light enough for a user to carry it; (3) it must be able to have wireless access to both strong base stations and reliable cellular or Wi-Fi networks through sufficient and efficient radio frequency spectrums so that low-power radio signals can be sent or received by thousands of users even in peak use time; and (4) it must have a small but powerful battery to provide power for long-term use.

These two basic features are useful for distinguishing a mobile phone from other various relevant technologies (e.g., mobile phones vs. cordless phones), clarifying various existing confusions among ordinary mobile phone users (e.g., mobile phones vs. automobile phones), and providing a good conceptual base for further research and application (e.g., When should we consider the starting point of mobile phones to be? Should we include both mobile phones and cordless phones together to study the possible cancer-causing effects of mobile phones?).

For instance, DynaTAC is a mobile phone because it has the two basic features. However, a traditional landline phone is a phone but not a mobile phone because it is not mobile and wireless. A cordless phone is a wireless phone but not a mobile phone because it does not connect with the cellular networks or with the Internet and can only be used to make calls within a small area. Automobile phones that are used in police cars or ambulances are not mobile phones because these phones are only mobile in the sense that you can drive around with them, but they are actually fixed in the vehicle and are too large and heavy to put into a pocket. A desktop computer is not a mobile phone since it does not have

the two basic features, despite it often having Internet access and the ability to send or receive emails. A pager is not a mobile phone because while it is portable, it does not really have the feature of voice or text communications. A television is neither mobile nor does it yet have a phone function, but it can actually become a feature of a mobile phone if it is integrated into a mobile phone, via various TV apps. A GPS device is not a mobile phone. While it is wirelessly connected to a satellite, its connection is one-way and is not interconnected with the public phone network. However, if it is integrated into a mobile phone, it becomes a feature of a mobile phone. A gaming console may be portable and interconnected to cellular networks (i.e., mobile gaming) or the Internet (e.g., online gaming), but its primary function is not for communication. However, if it is integrated into a mobile phone, it becomes a feature of mobile phone games. As for a computing tablet, it could be considered as a hybrid of a mobile phone and a computer. Given that a mobile phone normally has various computational functions (e.g., playing games) and a computer normally has various communicational functions (e.g., posting on Facebook), there is essentially no difference between a large mobile phone and a small tablet, as long as they meet the above two basic features.

2.2 *Modern Mobile Phones*

From DynaTAC or MicroTAC, the earliest classic mobile phones, to the iPhone 6 Plus or Samsung Galaxy S6 4G LTE, the most modern mobile phones, there are substantial differences. While modern mobile phones still share the two basic features, mobile and phone, they have been transformed into multi-functional, personal technologies.

According to Clayton Christensen,[4] the world's foremost authority on disruptive innovation, there exist four types of innovation: (1) Sustaining Innovation (it is expected and has no large effects, e.g., Microsoft produced Encarta as a digital encyclopedia to compete against *Encyclopædia Britannica* as the best print encyclopedia; (2) Evolutionary Innovation (it is expected and has large effects, e.g., fuel injection has become the current fuel delivery system in car engines to replace carburetors as the less efficient one); (3) Revolutionary Innovation (it is unexpected, but does not have large effects, e.g., the Concorde aircraft is supersonic, but ended its service

[4] Christensen, C. (2013). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.* Brighton, MA: Harvard Business Review Press.

in 2003); and (4) Disruptive Innovation (it is unexpected and has large effects, e.g., e-mail after postal mail, digital photography after chemical photography, and mobile phones after fixed line phones). Thus, we can consider that modern mobile phones are the new technology with two disruptive innovations.

First, *multi-function* technology. Due to the technology advancements, the modern mobile phones, often called smartphones, have become much more powerful than the classic mobile phones. This is achieved by (1) adding various new hardware devices such as cameras, GPS, and sensors, (2) having millions of new apps, and (3) linking with various new networks such as 4G or Wi-Fi. These so-called "smartphones" create additional capabilities besides the two basic functions. As a result, a small phone is no longer just a single voice-based communication tool with good mobility, but rather a strong technology that has multiple functions. It essentially integrates communicational technologies (e.g., a telephone from which one user can call or text to another), informational technologies (e.g., an Internet application that allows one user to browse the Internet), and computational technologies (e.g., a personal computer that allows one user to generate a file in Word) into a complex platform within a small size. Thus, a mobile phone may be able to identify its location using global positioning, may include a camera and various sensors, and may have substantial computing and memory abilities to make the device more useful to the user.

Second, *personal technology*. Along with the new feature of a multi-function technology, modern mobile phones become much more mobile in the sense that they do not limit the mobility of their users and eventually become much more personal. They have become cheaper, smaller, thinner, and faster, with a better interface. They are more useful and have more efficient batteries that can be recharged wirelessly. They have become much "smarter," with new sensors, new CPU chips, and new screens. Thus, mobile phone users start to build strong physical, cognitive, social, and emotional bonds with their mobile phones. Mobile phones can be used almost anywhere, at any time, by anyone, for anything.

As we can see, the two basic features of a classic mobile phone, *phone* and *mobile*, are closely related to the two advanced features of a modern mobile phone, *multi-function* and *personal*. It is extremely important for mobile phone users to know not only the basic features, but also the significant changes from the basic features to the advanced features. Mobile phones are no longer just mobile phones, but have evolved and transformed into a multi-function, personal technology. Knowing these

core changes enables us to see the current status of mobile phone use, the latest developments of mobile phones, wide variations of the mobile phone, actual impacts on humans, and tremendous potentials for mobile phone use.

2.3 Future Mobile Phones

If classic mobile phones are a communication tool with mobility, and modern mobile phones are a powerful multi-function personal technology, we might wonder: What will be the key feature of future mobile phones?

Right now, at least two major features have emerged. First, mobile phones are becoming a powerful remote control or a command center for the Internet of Everything. Second, mobile phones are becoming more wearable. An iWatch is a good example. In the next fifty years or so, with mobile phones becoming much more powerful and much more wearable, future mobile phones might possibly become a powerful artificial organ or the second brain of human beings for the first time in human history. The human body has various biological organs such as ears, eyes, heart, brain, arms, and legs. Future mobile phones might be so seamlessly personalized with human bodies that they become a special organ, and so powerful for serving human needs that they become a highly complex artificial technology. They will build on the current multiple functions and personal technologies. They might have strong artificial cognitive intelligence, artificial social intelligence, and artificial emotional intelligence. They might have a wide variety of modern sensors to receive input seamlessly and automatically, develop more computational capacities and various apps to store and analyze big data, and become a command execution center to effectively and efficiently perform almost every function for humans. Wherever the future might lead humans, one thing is clear: mobile phones will no longer feature just two functions, calling and texting.

3. Mobile Phone Behavior

What we have discussed in the previous section is about what mobile phones are rather than what mobile phone behavior is or how humans interact with mobile phones or how mobile phones affect human life. What is mobile phone behavior? How are mobile phones and mobile phone behavior related to each other? Is it true that mobile phone behavior is simply about calling parents or texting friends, as shown in those

informal responses from the graduate students? What are other kinds of mobile phone behavior? To answer these kinds of questions we might have, let us discuss five core concepts of mobile phone behavior in the following five subsections.

3.1 The Human Side

As mentioned earlier, the mobile phone DynaTAC used by Martin Cooper in 1973 is among the earliest mobile phones made by Motorola. Besides the mobile phone, there is much more involved in the first mobile phone call made in public in 1973, including the users of the mobile phone (the caller Martin Cooper to the invisible receiver Joel Engel), the action of making the call (e.g., dialing, walking while calling, purpose and content of the phone conversation), and the effect of the call (e.g., immediate and historical effects on human beings; possible cognitive, social, and emotional effects on Martin and Joel), as well as the context of the call (e.g., public relationships, media communications, research and development of mobile phones, the specific setting of Manhattan). These are all related to mobile phone use or mobile phone behavior, which is the human side of mobile phones rather than the technology side of mobile phones themselves.

As shown in Figure 1.1, the basic relationship between mobile phones and mobile phone behavior is analogous to that of a car and driving a car, a TV and watching a TV, a computer and using a computer. The former is about how an engineer invents and develops a technology – the technology side, and the latter is about how a user accesses and uses a technology – the human side. If the last section focuses on mobile phones as a powerful personal technology – the technology side of mobile phones, this section focuses on mobile phone use as a complex human behavior – the human side of mobile phones.

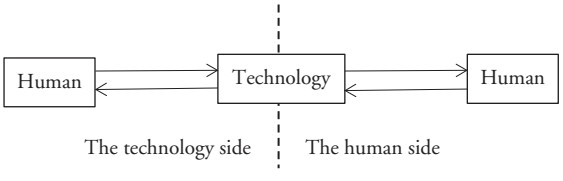

Figure 1.1 The Basic Relationship between Technologies and Humans

3.2 A Special Human Behavior

Researchers have studied various types of human behavior, such as health behavior, organization behavior, entrepreneurial behavior, violent behavior, economic behavior, sexual behavior, consumer behavior, social behavior, motor behavior, aggressive behavior, addictive behavior, machine behavior, cyber behavior (some of these are actually names or parts of names of academic journals). Behavioral science essentially is an interdisciplinary field that examines human behavior across various disciplines, including psychology, sociology, biology, medicine, law, business, education, criminology, neuroscience, psychiatry, economics, anthropology, and so forth.

As one specific type of human behavior, mobile phone behavior can broadly refer to any physical, cognitive, social, or emotional activity that humans engage in while using mobile phones. As observed in our daily lives and reported in the existing research literature, there exists a wide variety of mobile phone behavior, such as the use of mobile phones by people who are deaf or have dyslexia, sexting and its effects on children's social development, m-gaming, using mobile phones during disasters, mobile phones and sleep disturbances, m-consulting, mobile phones and brain tumors, calling and texting while driving, mobile phone distraction, mobile phone addiction, m-therapy, m-shopping, m-banking, m-learning, and m-voting. These types of mobile phone behavior will be systematically discussed in the subsequent nine chapters.

3.3 The Four Basic Elements

As shown in Figure 1.2, despite the extremely wide variety, mobile phone behavior primarily concerns four basic elements: mobile phone users, mobile phone technologies, mobile phone activities, and mobile phone effects. Based on the four elements, mobile phone behavior could be

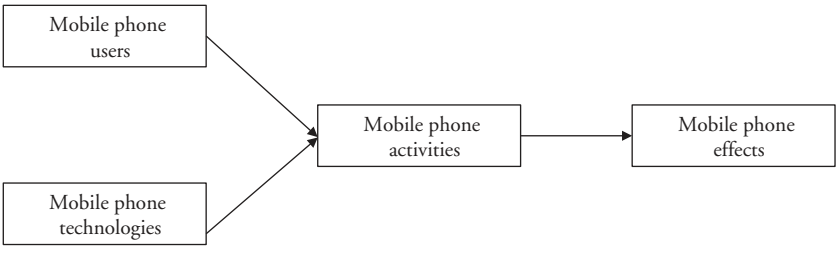

Figure 1.2 The Four Basic Elements of Mobile Phone Behavior