ABSTRACT

The Digitized Infant: A Field Study of Entangled Emotions and Affordances

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The digitization of one's personal data is of growing interest in the information systems discipline. Parents digitizing their infant's personal data in the form of infant monitoring is of particular interest. This study examines emotions and affordances within the context of remote infant monitoring. Through an affordance lens, this research conducts an exploratory field study to investigate the role of emotions in the use of an infant monitoring system (IMS). A qualitative analysis of 2,741 online reviews indicates emotional, behavioral, and physical drivers motivating the use of the IMS. Several emotional and behavioral affordances are available through the use of IMS features. Existing in tension with the affordances, constraints limit the affordances of the technology. Several positive and negative outcomes result from both the affordances and constraints. This research furthers the digitization of self literature by contributing to remote monitoring, emotions, and affordances through the development of the Affordance-Constraint-Outcome model.

The Digitized Infant: A Field Study of Entangled Emotions and Affordances

by

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A Dissertation

Approved by the Department of Information Systems

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Submitted to the Graduate Faculty of
Baylor University in Partial Fulfillment of the
Requirements for the Degree
of

Doctor of Philosophy

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August 2020

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ACKNOWLEDGMENTS

First and foremost, I want to thank my Lord and Savior, Jesus Christ, for giving me the resources and support I needed to complete this challenging program. Thank you to my parents for fostering in me a thirst for knowledge and a strong work ethic. I wish to express my sincere gratitude to Professor Leidner. Without her expert guidance, sound advice, and gentle mentorship, I would not have been successful in this program. There are too many others to acknowledge for their contributions to my success. Nevertheless, what is this section for other than to make an attempt? Dr. Burleson, I am forever grateful for your mentorship, advice, and all of the delicious dinners. Dr. Petter, thank you for your insights and passion for developing the doctoral students in the department and me into better researchers. Dr. Koch, I am grateful for your positive attitude and patience despite my ignorance as a first-year student. Dr. Tripp, thank you for teaching me how to recognize excellent research.

I would be remiss to not acknowledge my entire committee. Dr. Leidner, Dr. Burleson, Dr. Trower, and Dr. West, thank you for not just your excellent advice and direction, without which this dissertation would be much lower quality than it already is, but your academic mentorship as well.

DEDICATION

To the woman of my dreams, Kimberly, completing this dissertation would not have been possible without your endless love, support, and sacrifice

CHAPTER ONE

Introduction

Personal data digitalization, or the digitized self, is a growing phenomenon of interest in the IS field (e.g., Amaravadi 2003; Anderson and Agarwal 2011; Choi et al. 2018; Newell and Marabelli 2015). The digitized self revolves around the digitization of an individual's personal information. The benefits of the digitized self can include increased autonomy (e.g., Karahanna et al. 2018), better health (e.g., Rosen et al. 2015; Varma et al. 2010), or better knowledge of one's activity and movement (e.g., Prasopoulou 2017). These benefits can be summarized as knowing oneself (Leidner and Tona 2020).

Demographic (e.g., Amaravadi 2003; Hann et al. 2007), financial (e.g., Luo et al. 2010), and health data (e.g., Ozdemir et al. 2011) comprise the early research on personal data. Further research has broadened to include examining social media data (e.g., Choi et al. 2018; Salehan et al. 2017) and physical data from wearable devices (e.g., Prasopoulou 2017). Finally, the digitalized self can also be characterized by digital traces that come from user interaction with digital services (e.g., Lehrer et al. 2018; Newell and Marabelli 2015). The transition in the types of personal data mirrors the technology studied. The technology studied has advanced from e-commerce websites (e.g., McKnight et al. 2002) to social media platforms (e.g., Karahanna et al. 2018; Salehan et al. 2017), to wearable devices (Prasopoulou 2017), mobile applications (e.g., Luo et al. 2010), and algorithms (e.g., Newell and Marabelli 2015). Digitalization and tracking of personal data can enable an individual to know themselves better and, presumably, make better decisions about themselves.

A typical example of digitizing oneself is activity trackers. Activity trackers, whether through personal use (Prasopoulou 2017) or as a part of a corporate wellness program (Giddens et al. 2017), enable users better to understand their movement and activity levels throughout the day. Most activity trackers count the number of steps taken by the user. More advanced trackers use GPS to track location and sensors to measure heart rate. All of this personal information can be available to the individual through the hardware itself, a mobile application, or online.

Infant monitoring is an example beyond simply knowing oneself, like activity trackers, but the digitalization of the most fragile in society, infant children (Junqing Wang et al. 2017). Infant monitoring can manifest through audio/visual monitoring and, more recently, biologic monitoring of the infant. The continuous monitoring of an infant is of particular interest as it involves the digitization of an infant's biologic status by the infant's caretakers. This digitization of the infant has garnered recent controversy in both peer-reviewed publications and the popular press (Bonafide et al. 2018; Godwin 2019; Hogan 2018) with parents claiming to use it to ease the anxiety associated with SIDs and the American Academy of Pediatrics recommending that the technology not be used to reduce the risk of SIDs (Task Force on Sudden Infant Death Syndrome 2016). While there is controversy as to whether it benefits the infant (King 2014), parents report greater peace of mind and sleep (Dangerfield et al. 2017). However, the continuous stream of data might increase parental anxiety. Relying on the data stream could hinder the development of parental intuition. The use of the technology might distance parents from their infants (Gaunt et al. 2014).

In this study, I seek to understand the role of emotions in parents choosing to use infant monitoring in caring for their infants. Providing care for a newborn can be an overwhelming, stressful, and emotional experience (Barclay et al. 1997; Gaunt et al. 2014; Miller and Myers-Walls 1983). Emotions have long been a construct studied in the IS literature (Beaudry and Pinsonneault 2010; Venkatesh 2000; Zhang 2013). The emotions examined in the previous research are emotions experienced in response to an IS stimulus during the period the IS is being deployed within an organizational setting (Beaudry and Pinsonneault 2010). This study examines emotions that are anticipatory in response to a non-IS stimulus, the burden of caring for an infant, where the user introduces an IS to calm the experienced emotions. Because caring for a new infant is one of the most stressful periods in a family (Miller and Myers-Walls 1983), studying the role of emotions in this context is appropriate.

I use affordance theory to explain the caregivers' choice to digitize their newborn by using an infant monitoring system (IMS). Affordances, as defined by affordance theory, exist in the relationship between the features of a technology and the goals of the user (Gibson 1977; Volkoff and Strong 2013). The Needs-Affordance-Features (NAF) model (Karahanna et al. 2018) examines the relationship between the user's psychological needs and the affordances provided by social media features. Not included in the NAF perspective are the outcomes of the affordances beyond fulfilling the user's needs. This study adds both the outcomes of and constraints to affordances. Including both positive and negative outcomes and constraints reveals a tension between the affordances and constraints. Furthermore, this study goes beyond the user's psychological needs and incorporates the behavioral, physical, and emotional drivers motivating the use of the IS. In summary, this study answers the research question: *"How are emotions entangled with the affordances of infant monitoring?"*

To answer this question, I conduct an exploratory, qualitative study into how and why caregivers choose to use a specific IMS. For this study, the Owlet Smart Sock was picked as the IMS. The Owlet is an IMS that monitors an infant's heart rate and oxygen saturation through a sock sensor. This device produces an alert if the infant's heart rate is too high or low or if the infant's oxygen saturation is too low so that the caregiver can respond and provide any necessary care. Using online reviews of the IMS, I identify the emotions and affordances involved in using the IMS and theorize the relationships between them.

The Affordance-Constraint-Outcome model developed as the result of this study theorizes the relationship and interactions between the drivers, affordances, constraints, and outcomes of using the IMS. The findings show an emotional component to each of these constructs. This research goes further to map each of the identified drivers to their respective affordances and each of the affordances or constraints to their respective outcomes. The Affordance-Constraint-Outcome model and the resulting findings explain the entanglement of emotions, affordances, and constraints in infant monitoring use.

This dissertation proceeds as follows. Chapter Two describes the extant literature on remote monitoring and emotions. It describes the gaps in the literature that this study fills. Chapter Three presents the theoretical foundation for this study to include affordance theory and the NAF model. In describing affordance theory, limitations in the current affordance literature are explained. I describe the data and methodology in Chapter Four. Chapter Five includes the analysis of the data. Chapter Six presents the major findings, implications, and limitations of the study. Chapter Seven concludes the dissertation with a summary of the research.

CHAPTER TWO

Literature Review

To thoroughly review the necessary literature for this study, I review three separate streams of literature. First, I examine how remote health monitoring has been studied in both the business and medical literature. Following the review of remote monitoring, I examine the literature on emotions. Finally, I review how the IS discipline has studied emotions.

Remote Monitoring of Others

Methodology of Literature Review

When searching the literature for relevant articles on remote health monitoring, I intended to gather a representative sample of what has been published on the remote monitoring of others across both the medical and business literature. Thus, I claim to make a representative, not exhaustive, search of the literature. In the initial search, I pinged the article titles, abstracts, and keywords of all the peer-reviewed journals in two databases, PubMed and Business Source Complete (EBSCOHost). These two databases were used due to the large variety of business, information systems, health, and technology-oriented journals. I used the following phrase to search article titles, abstracts and keywords of each database: "remote monitoring." I added the following Boolean phrase to the EBSCOHost search: "…AND health*" to limit the search results to health-related articles. Additionally, I conducted another search of EBSCOHost using the term "telecare" as telecare is a similar term that used more in the European journals. The only limitations included in these searches were that the articles had to come from scholarly, peer-reviewed publications. I set no limit on the publication date. Conference papers were included as long as they met the previous criteria.

These three searches initially returned 165 articles for review. Upon examination of the article abstracts, 72 of the articles were excluded for not being focused on remote patient monitoring or health. Nine articles were excluded for not being written in the first or second languages of the authors, and two were excluded for being duplicates. An additional 15, while helpful to the understanding of RPM research, were removed for being commentaries, opinions, or literature reviews and not empirical research. This left 63 studies to be included. An additional six articles were added through a forward/backward search, leading to a final total of 69 articles included in this literature review.

Types of Individuals and Conditions Monitored

Within the context of remote monitoring, there are many broad applications of different technologies. While all of the studies related to the monitoring of individuals outside of the clinical setting, they covered a wide gamut of types of individuals with varying diseases, ranging from vital sign monitoring of infants (Lin et al. 2017), to the monitoring of juveniles with heart failure (Silvetti et al. 2016), to the monitoring of home-bound geriatrics (Barlow et al. 2006). While individuals with cardiac issues comprised the largest segment of conditions studied (e.g., Ahmed et al., 2016; Crossley et al., 2011; Nicolini, 2010; Zanaboni et al., 2013), other conditions studied included brain injuries (D'Arcy et al. 2011), diabetes (Cherry et al. 2002; Dadgar and Joshi 2018), AIDS

(Rosen et al. 2015), and amputees (Klute et al. 2009). The conditions listed are not meant to be comprehensive, but to provide an overview of the types of conditions monitored.

Remote Monitoring Ecosystem

Remote health monitoring is a system that incorporates everything from the actual sensor, to the individual whose health information is being digitalized to the outside observer of the individual. Figure 2.1 shows a generic remote health monitoring system. At the center of the system is the sensor itself. The sensor is the device that monitors the individual. It usually consists of a sensor, data storage, and a transmitter. This combination can manifest itself in a single device that can monitor the individual, store the data and then transmit the data to multiple devices with each serving the purpose of either operating as a sensor, storage device, and/or a data transmitter. After collecting the data from the individual, the device either transmits the data directly to the individuals who are doing the monitoring or through a service provider that analyzes and organizes the data before transmitting it to the observer. The arrows in Figure 2.1 can represent a direct transfer of the data, a transfer to a 3rd party storage location where it is forwarded on to the appropriate individuals, or a transfer to a 3rd party storage location where it has to be retrieved by the appropriate individuals.

Typology of Remote Monitoring Technologies

The remote monitoring literature revealed four differentiating design elements of the remote monitoring: continuous, non-continuous, biologic, and non-biologic. Table 2.1 defines each category along with an example technology and example findings for each category. While continuous/non-continuous is binary, a remote monitoring system can monitor both the biologic and non-biologic status of an individual simultaneously. This

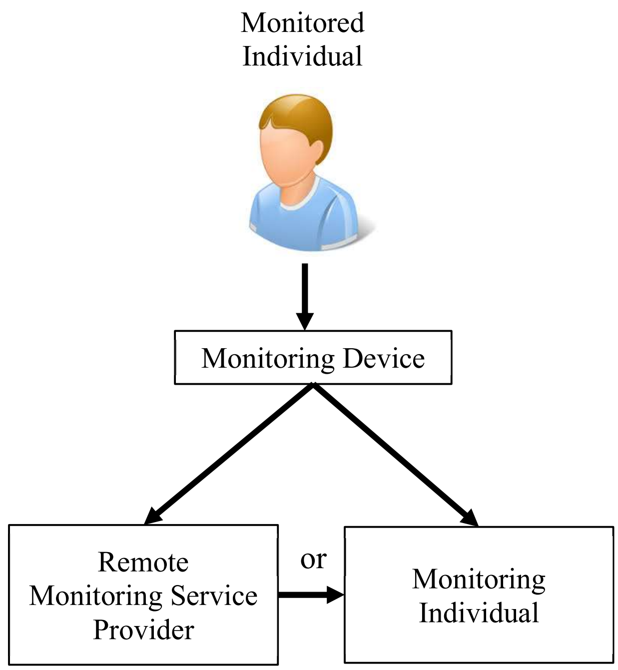

Figure 2.1 Remote Monitoring System

leads to six different types of remote monitoring: continuous-biologic, non-continuous-biologic, continuous-non-biologic, non-continuous-non-biologic, continuous-both, and non-continuous-both. Of the 69 articles reviewed, a similar number of articles were classified as either continuous-biologic or non-continuous-biologic, with 18 being continuous-biologic and 20 being non-continuous-biologic. Five continuous-non-biologic and only one non-continuous-non-biologic articles were reviewed. Just under a quarter of the articles reviewed, 17 total, monitored both the physiological symptoms and the non-biologic status of the individual. Twelve of these articles studied continuous monitoring and five of them non-continuous. Finally, 7 of the reviewed articles did not specify the type of remote monitoring studied or studied multiple different types.

Just over a quarter of the reviewed articles studied were a continuous, biologic RPM system. This type of system monitors the physiological status of an individual without intervention from that individual. While these devices continuously gather the

Table 2.1. RPM Type Definitions and Examples

Type	Definition	Example Technology	Example Findings
Continuous, Biologic	Gathers the physiological status of the person *without* the intervention of the person being monitored	Vital sign sensors ICDs	Demonstrate feasibility in remotely collecting vital signs (Bakhtiaria et al., 2012) Improved key metrics for heart failure patients (Varma et al., 2010)
Continuous, Non-biologic	Gathers data on the environment around the person status of the device, or non-physiological status of the person *without* the intervention of the person being monitored	Mobility sensors	Developed the technology to detect falls using radar (Ahmad et al., 2015) Able to correctly monitor joint orientation of mobility patients (Parveneh et al., 2017)
Continuous, Both	Gather both the physiological status of the patient and data on the environment on the environment around the person, status of the medical device, or non-physiological status of the person *without* the intervention of the person being monitored	Geriatric smart homes	Wearable technologies may help geriatric patients with chronic diseases (Armstrong et al., 2017) Existing organizational boundaries limited effectiveness of smart home program (Barlow et al., 2006)
Non-Continuous, Biologic	Monitors physiological status of the person *with* the intervention of the person being monitored	mHealth Apps	Overall positive patient attitude towards mHealth monitoring in kidney transplants (McGillicuddy et al., 2013) and post-surgical patients (Gunter et al., 2018)
Non-Continuous, Non-Biologic	Gathers data on the environment around the person, status of the device, or non-physiological status of the person *with* the intervention of the person being monitored	Artificial Heart Valve	Able to accurately detect abnormal heart valve sounds in all patients (Frizche et al., 2005)
Non-Continuous, both	Gather both the physiological status of the person and data on the environment around person, status of the device, or non-physiological status of the person *with* the intervention of the person being monitored	mHealth Apps	Twelve derived patient values associated with diabetes app enable self-management activities (Dadgar and Joshi, 2018) The patients understanding and reaction to visuals in the mHealth app were essential to the design (Rosen et al., 2015)

data, they may or may not require some action to transmit the data to either the monitoring individual or the remote monitoring service provider. Most of the continuous biologic systems that automatically transmit the data monitor one or more of an individual's basic vital signs (pulse rate, respiratory rate, blood pressure, SpO_2, etc.). Some of these technologies use traditional medical sensors that automatically gather and transmit the vital sign data (Anagnostaki et al. 2002; Arzbaecher et al. 2010; Fanucci et al. 2013; Kang et al. 2006; Preejith et al. 2016; Woo et al. 2018), while others used contactless sensors or body area networks to continuously collect and transmit the vital sign data (Bakhtiari et al. 2012; Fortino et al. 2014; Lin et al. 2017; Rebeiz et al. 2012). The majority of the systems that continuously collect the data but require an intervention from the patient to transmit the data are implantable cardiac devices (ICD). These ICDs monitor an individual's heart for arrhythmias and other irregularities. While the data is continuously gathered by these ICDs without the intervention of the patient, for the data to be transmitted, the device must be manually read by the transmitting device before sending to the individual's physician (Ahmed et al. 2016; Brasca et al. 2017; Buchta et al. 2017; Nagel et al. 2014; Silvetti et al. 2016; Varma et al. 2010; Zanaboni et al. 2013). Finally, one study developed a wearable device to continuously monitor one's stress level (Tartarisco et al. 2012).

A remote monitoring system that also monitors the physiological symptoms of an individual but requires that individual to take an action to help it gather the data is a non-continuous, biologic system. This category represented the most variation in the types of technologies used and individuals monitored. Some of these technologies are similar to the continuous systems, but differ solely in the fact that they required the person to step on a scale to track their weight or temporarily wear a pulsometer to measure their heart rate (Blount et al. 2007; Kirsch et al. 2007; McElroy et al. 2016; Nguyen et al. 2014; Qureshi et al. 2015; Singh et al. 2011). Others used specific, manual sensors to track brain injuries (D'Arcy et al. 2011), long- term electrocardiogram patients (Di Cori and De Lucia 2018), heart failure patients (Gussak et al. 2012; Nicolini 2010; Oudshoorn 2012; Reiss et al. 2017), post-surgical patients (Gunter et al. 2018; Pombo et al. 2014), kidney transplants (McGillicuddy et al. 2013), and lower extremity rehabilitation patients (Karime et al. 2012). Finally, there is a segment of remote monitoring systems related to the monitoring of frail, aging individuals that requires these individuals to use a specific technology to reach a third-party service provider through sensors and video-teleconferencing technology (Boonstra and van Offenbeek 2010; Guillén et al. 2002; Roberts et al. 2012; Wilson et al. 2017).

A continuous, non-biologic system is one that requires no action on the part of the individual to gather the data and monitor the environment around the individual, the status of a medical device, and/or the non-physiological status of the individual. Most of these technologies are related to mobility by either detecting falls using radar (Ahmad et al. 2015) or monitoring a person's current mobility (Lebel et al. 2016; Nguyen et al. 2015; Parvaneh et al. 2017). Finally, one uses radio-telemetry to monitor the device function of muscle-powered implants (Trumble and Magovern 2001).

A non-continuous, non-biologic system monitors the same tasks as continuous, but requires the individual to accomplish some action before gathering the data. This type of RPM system is antiquated because a non-continuous, non-biologic system does not take advantage of the benefits of continuously monitoring the environment around the individual. Thus, this type represents the smallest segment of the technologies studied, with only one article reviewed studying a non-continuous, non-biologic system. This single study examined a technology that monitors and listens for the failure of a mechanical heart valve. This technology differs from the heart monitors mentioned in the following paragraphs in that it only monitors the status of the artificial heart valve and does not monitor the function of the patient's heart (Fritzsche et al. 2005).

Contrary to the previous remote monitoring technologies that conducted either biologic or non-biologic monitoring, there are several examples in the literature of technologies that monitor both. Conventional continuous, biologic and non-biologic remote monitoring systems include ICDs and various systems designed to monitor geriatric patients in their homes. The ICDs reported in the literature continuously track the status of an individual's heartbeat for any arrhythmias or irregular cardiac events while also monitoring for any device malfunctions, specifically lead failures (Crossley et al. 2011; Heidbüchel et al. 2008; Nishii et al. 2017; Schoenfeld et al. 2004). While this common type of remote monitoring system continuously gathers data on the status of both the device and the individual's heart rhythm, it does not transmit the data continuously. This is accomplished at a regular interval, usually while the individual sleeps, as the ICD connects to a bedside device that transmits the data. The other most common examples of this type of remote monitoring are typically part of a smart home (Barlow et al. 2005) and monitor both the vital signs of elderly individuals and the environment around them or their non-physiological status (i.e., whether the individual has fallen, not returned to bed in the middle of the night, etc.) (Armstrong et al. 2017; Barlow et al. 2005, 2006; Lamprinakos et al. 2015). Other less common examples of remote monitoring systems that continuously monitor both the physiological status of an individual and the environment around the individual are smart prosthetics that monitor the status of the individual and the status of the prosthesis (Klute et al. 2009) and remotely monitored ventilators that can detect sleep apnea events and the status of the ventilation tube (Battista 2016).

Non-continuous, biologic and non-biologic remote monitoring systems are devices that conduct biologic and non-biologic monitoring in parallel but require the monitored individual to take some action for the device to gather the data. These technologies are centered around mobile applications that allow individuals to use their smartphone to gather both physiological data and non-physiological data. One example is mobile applications that monitor a diabetic's blood sugar levels, medication use, diet, and exercise (Cherry et al. 2002; Dadgar and Joshi 2018). Another example is a mobile application that allows post-colorectal surgery patients to complete a survey on their current bowel function, pain levels, medication use, and wound care (Dawes et al. 2015). In this example, the individuals would send this information daily along with a picture of their surgical wound to their physician for evaluation.

In summary, this review of the remote health monitoring literature shows how the monitoring is accomplished by classifying the type of monitoring from continuous to non-continuous monitoring. The review also shows what is being monitored, from the biological status of the individual to the environment around the individual. While many of the studies are interested in revealing the physical, more easily measured outcomes of using remote health monitoring like reduced cost (Cherry et al. 2002; Klute et al. 2009) and increased efficiency (Nguyen et al. 2014; Singh et al. 2011), they tend to ignore the emotional and behavioral impacts on both the individual being monitored and the one doing the monitoring. Additionally, they tend to neglect how the impact is achieved. Again, by primarily studying the outcomes, whether it is health or cost-related, of remote health monitoring, the literature assumes that individuals use remote health monitoring because of the positive physical outcomes of its use. Other outcomes associated with the use of remote monitoring are ignored. A change in emotional state is a well-known, but not well-studied, outcome of the use of technology that might apply to remote monitoring. To help examine emotional responses as a potential driver or outcome of the use of remote monitoring, in the next section, I examine emotion and how it has been studied in the literature.

Emotion

Impacts of Emotion

Emotion is one of the more mysterious, complex constructs within the psyche of human beings (Russell 2003; Zhang 2013). Emotion plays a crucial role in motivation (Reeve 2015), can be viewed as both rational or irrational (Pham 2007), and can influence how a person responds to a stimulus, perceives an event, thinks, and acts (Anderson and Agarwal 2011; Brief 2001; Forgas 1995; Tooby and Cosmides 2008; Zhang 2013).

Traditional Research View of Emotion

Emotion has traditionally been theorized as consisting of at least two dimensions, arousal and valence (Russell 1980). Arousal varies from activated to deactivated (Russell 1980) and valence varies on a spectrum from pleasure to displeasure (Lerner and Keltner

2000). Emotions can be categorized within these dimensions. Figure 2.2, adapted from (Russell 2003), shows how different commonly experienced emotions would fit within these dimensions. For example, the emotion of excitement can be categorized as very activated on the arousal scale, but is only slightly towards pleasurable on the valence scale. In contrast, calm is on a similar level of pleasure on the valence scale, but much more towards deactivated on the arousal scale. On the displeasure end of the valence spectrum, frustrated and anxious are more activated while sad and tired are more deactivated. The emotions listed are not meant to be all-inclusive, but only act as examples of the dimensions of emotion. Much research has used these dimensions or a version of these dimensions when studying emotion (e.g., Chen et al. 2019; Fehrenbacher 2017; Teubner et al. 2015)

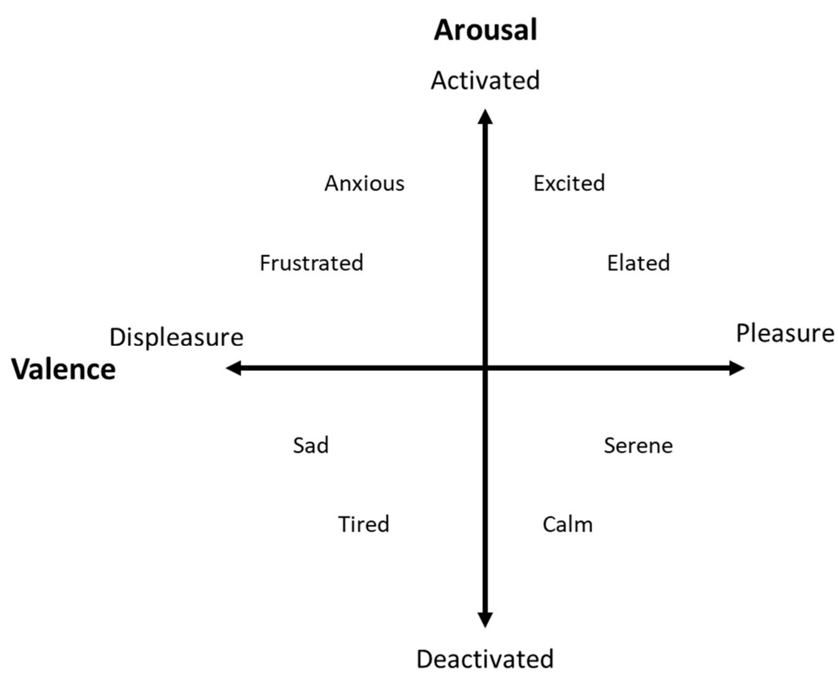

Figure 2.2. Circumplex Model of Emotion adapted from (Russell 2003)

Key Emotional Constructs

Three critical terms repeated within the emotion literature are core affect, stimulus, and affective response (Russell 2003; Zhang 2013). Both core affect and affective response can be plotted in Figure 2.2 on the circumplex model of emotion based on the valence and arousal of the emotion felt. Table 2.2 provides the definitions for these three terms. Core affect is defined as the free-floating state defined by a blend of the previously mentioned dimensions of arousal and valence (Russell 2003). It can have no known cause or be connected to a specific stimulus (Zhang 2013). Core affect is not to be confused with the term affect. Affect is usually referred to as an umbrella concept regarding a cognitive process involving internal feelings (Yin et al. 2014). Stimulus is the real or imagined object to which an individual directs an affective response (Russell 2003; Zhang 2013). Finally, emotion is the temporal or non-temporal change to an individual's state due to a specific stimulus (Zhang 2013). As such, emotion can be considered a specific form of affect being defined as a temporary, affective response to a specific stimulus (Stein et al. 2015; Zhang 2013). While it is easy to conflate the two constructs of emotion and affect, I will follow the lead of Stein et al. (2015) and differentiate the constructs by equating emotion to an affective response. Thus, I will use the term emotion when referring to an individual's affective response to a stimulus. The following section describes how emotions have been researched within the IS literature.

Emotion within the IS literature

Within the IS literature, emotion has been studied both directly and indirectly with studies either directly researching the role of emotions in an IS context (e.g., Zhang 2013) or simply adding emotion as one construct to a complex model (Venkatesh 2000).

Table 2.2. Key Constructs in the Emotions Literature

Construct	Definition
Core Affect	An individual's free-floating state defined by a blend of the dimensions of arousal and valence
Stimulus	The real or imagined object to which an individual directs an affective response
Emotion/Affective Response	A temporary or non-temporary change to an individual's core affect due to a specific stimulus

Beaudry and Pinsonneault (2010) provide an excellent review of how emotions have been studies within the IS literature. They classify the emotional literature within the IS field as studying emotions that occur in anticipation of an IS stimulus or during the impact period of an IS stimulus. To help understand how emotions have been studied within the IS literature, I update Beaudry and Pinsonneault's (2010) review to include studies published with *MIS Quarterly, Information Systems Research,* and *Journal of the Association of Information Systems* since 2010. However, in addition to classifying the emotions as occurring in anticipation of an IS stimulus or during the impact period of an IS stimulus, I classify whether the stimulus is an IS stimulus or a non-IS stimulus. Table A.1, in the appendix, summarizes this updated review.

The four different classifications in which I categorized emotions in the IS literature are visualized in a two-by-two matrix shown in Figure 2.3. The bottom left quadrant represents research that studies emotions that are in response to an IS stimulus during or after the impact period of the stimulus. This quadrant represents the largest segment of articles within the IS literature examining emotion. The research in this segment has a wide variety of emotions and IS stimuli. Despite the variety and potential for even more variety, the general use of a personal computer, interaction with a website, or online purchase are the most common IS stimuli (e.g., Park et al. 2019; Venkatesh 1999; Zhang 2013). Despite these generic IS stimuli, the specific emotional responses studied vary from the positive emotions of enjoyment (e.g., Al-Natour et al. 2011; Davis et al. 1992; Koufaris 2002), flow (e.g., Webster et al. 1993), and happiness (e.g., Burns et al. 2019; Cenfetelli 2004) to the negative emotions of anxiety (e.g., Brown et al. 2004; Todman and Monaghan 1994; Venkatesh et al. 2003), frustration (Ormond et al. 2019), and sadness (e.g., Burns et al. 2019; Dissanayake et al. 2019). These many emotions demonstrate the variation in emotional responses with the literature showing that the emotional response to an IS stimulus in the impact period can be mixed and are a reaction to personalized, situational events (Stein et al. 2015). While most of the studies in this quadrant define and study explicit emotions, they are generally classified as either positive or negative emotions.

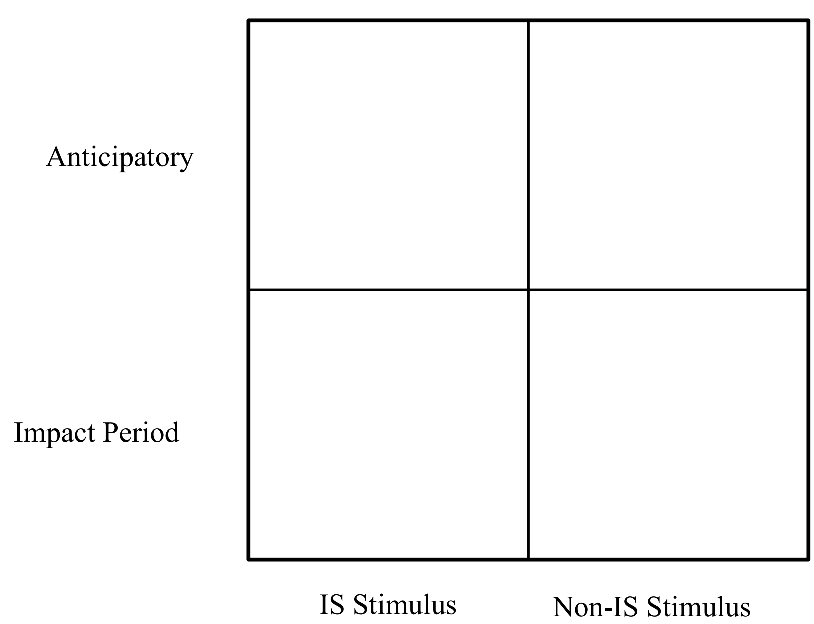

Figure 2.3. Classification of Emotions in IS Literature

The top left quadrant represents research that studies emotions in anticipation of an IS stimulus. These anticipatory emotions occur before an IS event even occurs. The emotions to an anticipated event include enjoyment and anxiety. While the enjoyment is in reaction to the anticipated use of a personal computer (Chin and Gopal 1995), the anxiety is related to vulnerability to a phishing attack that may or may not occur (Jingguo Wang et al. 2017). Other anticipatory emotions researched include the mental state of action to the imminent deployment of a new IS (Beaudry and Pinsonneault 2010) and the imagined emotional consequences of contributing to an online community (Tsai and Bagozzi 2014). The articles classified into this quadrant are split into studying specific emotions and more general emotional responses. It is also an emerging area of emotional research as three of the four articles reviews in this quadrant were published in the last decade.

The bottom right quadrant represents those studies that examine emotions during the impact period. However, the emotions are in response to a non-IS stimulus. It has recently emerged as an area of research within the IS discipline. Within these studies, the emotions and stimulus are not directly related to the IS artifact. However, the IS artifact is found in either the methodology, the impact of the emotions studied, or both. Fehrenbacher (2017) conducted a laboratory experiment to study the impact of the recognition of emotions on a knowledge requester's face on knowledge-sharing decisions. This research contributes to the IS emotion literature in both its methodology and findings. It uses a complex IS within the methodology to electronically track the receiver's facial expression to determine emotional valence. In addition to the methodology, the impact on IS via knowledge sharing and measurement of emotional valence via electronic face tracking is readily apparent. Despite the advanced methodology and knowledge sharing related findings, the only emotions studied are positive valence (happy) and negative valence (angry) emotions. Hong et al. (2016) look at emotions embedded in the online reviews of different restaurants in different cultures. This research found online reviews with less emotion were perceived as being more helpful than those with more emotion. In this study, the stimulus, assumed as it is not explicitly studied or discussed, is a reviewer's experience in a restaurant. However, this emotion, as expressed in an online review, has an impact on the perceived helpfulness of the online review. This study does not examine any specific emotions. It only counts the total number of emotional words in each review as indicated by the *Linguistic Inquiry and Word Count* (LIWC2015) software. Only two of the articles reviewed fit into this category. In summary, the research within this category either looked at emotions, in general, or just a simple differentiation between positive and negative valence emotions.

Finally, the top right quadrant represents the category of emotions research in the IS literature that studies anticipatory emotions that arise from a non-IS stimulus. Anderson and Agarwal (2011) study a patient's willingness to provide private health information in the age of digital healthcare. The article shows that a patient's negative emotions about one's anticipated health status influence the willingness to provide access to private health information. The negative emotions are anticipatory in that the individuals in the study do not know or understand their current health status because they have not received a confirmed diagnosis, the non-IS stimulus. However, they contribute to the IS literature as they show that negative emotions have an impact on willingness to share sharing health information online. With only this one article fitting the criteria of the top-right quadrant, this is the least-represented category in the IS literature.

The review of both the remote monitoring literature and the emotions literature reveals several themes and gaps that motivate this research. First, while there are several different types of remote monitoring, continuous-biologic and continuous-both type remote monitoring provide the most opportunity for research in a world of constant connectivity. The remote health monitoring research tends to focus on the positive, physical outcomes of its use and ignores the emotional and behavioral impacts on both the individuals being monitored and the individual conducting the monitoring. Second, while there is robust research in the IS discipline on emotional reactions to an IS stimulus during the impact period of the introduction of that stimulus, there is a research gap related to the research of anticipatory emotions and emotions in reaction to a non-IS stimulus. Third, the emotional research in the IS discipline primarily focuses on either general emotions or categorizes the emotions studied as merely positive or negative emotions on the valence axis. They tend to completely ignore arousal when studying emotions, especially in the emerging research on anticipatory emotions and emotions reacting to a non-IS stimulus.

This study fills the identified gaps by helping to show the role of emotions, from a non-IS stimulus, in driving the use of a technology; thus, moving the emotions experienced from the right side to the left side of Figure 2.3. This research will shed light on how the coping behaviors associated with the emotions in anticipation and during the impact period of a non-IS stimulus can lead to the introduction of an IS stimulus, that of infant monitoring. This IS stimulus can produce a wide range of emotions both in anticipation and during the impact period of the IS stimulus. These emotional responses can either help or be in detriment to the initial emotions to the non-IS stimulus. In summary, this study fills a gap in the remote monitoring and emotional literature by examining the role of both anticipatory and impact-period emotions on the use of continuous, remote health monitoring systems. This study also examines the emotional outcomes of using a continuous, remote health monitoring system. Finally, this study fills a gap in the literature by examining specific emotions defined by both valence and arousal instead of the commonly seen positive vs. negative emotions. The next section describes the theoretical background for this study.

CHAPTER THREE

Theoretical Foundation

As the use of information systems has become more voluntary and widespread, different theoretical perspectives that examine what motivates human action need to be brought to the forefront, beyond the foundational theories of reasoned action and planned behavior (Karahanna et al. 2018). In detailing the theoretical foundation that supports this study, this chapter describes the history of affordance theory and how it has been applied to technology. It then details the NAF perspective (Karahanna et al. 2018) upon which the model in this research is developed.

Affordance Theory

Affordance theory provides a powerful lens through which to study how users choose to use a particular technology and the outcomes of that use (Leidner et al. 2018). Affordance theory originates from the psychological idea that cues in the environment can indicate the possibility for an action or an opportunity (Gibson 1977). In general, an affordance is an action or possibility for action offered to an individual by an object (Leidner et al. 2018). They may or not be actualized or even perceived (Volkoff and Strong 2013). When defining affordances, it is essential to separate the affordance from the use of features and the outcomes of use (Leidner et al. 2018). While this separation can be onerous, it must be done both theoretically and methodologically (Leidner et al. 2018).

Affordances are relational in that they involve a user's goals, the features of the technology, and how the technology was designed to be used. Researchers have taken two differing, but not necessarily contradictory, perspectives when it comes to this relationship. One perspective is the user's perspective, where the relationship is defined as between the user and the features of the technology. The other perspective is the designer's perspective, where the relationship is more defined as existing between the designers of the technology—and their specific design choices—and the end-user. I will first explain the user's perspective and then the designer's perspective within the context of affordance theory.

The user's perspective of affordance theory is the predominant perspective in the recent IS literature (Karahanna et al. 2018; Leidner et al. 2018; Leonardi 2013; Vaast et al. 2017). This relational view of affordances involves the interaction between the user, their environment, and the features of the information technology. It emphasizes that a user's goals are what drive the enactment of affordances (Leonardi 2013). The use of specific technology can result in many different affordances based on the user's goals and the mix of features used (Leonardi 2013; Vaast et al. 2017). As previously stated, recent research from this perspective emphasizes the importance of distinguishing between affordances, use, and outcomes of use (Leidner et al. 2018)

The designer's perspective of technology emphasizes the communication between the designer and the end-user through the specific design choices of the designer (Faraj and Azad 2013). This perspective was first introduced into the IS field in the 1980s as a part of the intuitive design of technology (Faraj and Azad 2013; Norman 2013). This perspective argues that the specific design choices of the designer directly communicated with the user. The perceived affordances indicated by the design choices guide the user in a specific way of using the technology. However, affordance theory research, from the designer's perspective, has gone away from intuitive design and towards recognizing any unique or surprising ways the end-users choose to interact with the technology (Faraj and Azad 2013). Thus, while the perspectives are differing, they do not necessarily contradict each other. The user's perspective is about the affordances the user can enact regarding features of the technology and the goals of the use. The designer's perspective is about the affordances the design can foresee and build into the technology through the design of features.

While the two perspectives are different, they do not contradict each other. They offer a variety of options to the researcher. One emphasizes the design choices of the developer influencing the affordances, and the other focuses on the goals of the user. One focuses on the design of affordances, while the other focuses on the enactment of affordances. This study primarily takes the user's perspective when examining the affordances provided by infant monitoring. It also incorporates the designer's perspective through the analysis of the features used and how the designer changed the features available over time.

The IS community has also theorized affordances on multiple levels with individualized, shared, and collective affordances (Leonardi 2013). Individualized affordances are individual-level affordances that are enacted when an individual uses an IS to complete an action that others might not be able to accomplish. An enacted individualized affordance might lead to a gain of power or status for the individual within a group. Shared affordances are affordances that are shared within a group. With shared affordances, each group member uses the technology in a similar way to enact the same affordance. A collective affordance is a group-level affordance where the individuals use the technology in different ways so that, when pooled, their individual use leads to a group-level affordance.

Researchers often use examples and analogies when explaining affordances to include transportation to work (Leidner et al. 2018), a tree (Faraj and Azad 2013), or sitting on a log (Volkoff and Strong 2013). However, one of the earlier examples used in the literature was of the use of a bench (Gibson 1977). As Gibson (1977) explains, humans typically sit, as opposed to kneeling or squatting. Thus, a horizontal, flat surface that is about knee-high affords an individual the opportunity to sit. It is relative to the individual as knee-high for a child is different than it is for an adult. Using this simple example, I will demonstrate the separation of use of features, outcomes of use, and affordances. Imagine a hiker is reaching the apex of a strenuous hike. Reaching a solid, wooden surface, the hiker immediately perceives the opportunity to sit. In dire need of some rest, the hiker sits on the bench. Using the bench is the act of sitting on the surface while the affordance is the opportunity to rest. The outcome of the affordance is that the hiker feels rested. In addition, the hiker can enjoy a picturesque view while sitting on the bench that would not otherwise be enjoyed. The use of the bench, sitting, also affords the ability to enjoy the view. An outcome of this affordance might be the sense of awe, wonderment, and satisfaction of enjoying such a scenic landscape. Sitting on the bench is not an affordance; it is the use of the bench. Taking advantage of the use of the bench to rest, enjoy the view, or both are just two of the potential affordances provided by the bench. The outcomes of the affordances can also be separated from the outcomes of the use of the bench. The outcome of using the bench is the tautological fact that the hiker gets to sit. Conceptually different than purely sitting is the outcomes of the affordances. As previously stated, outcomes of resting and enjoying the view can be linked to their respective affordance, whether it is a physical rejuvenation from rest or a sense of calm and satisfaction from observing nature. Sitting on the bench can result in the enactment of two separate affordances, rest and enjoying the view. These affordances each have outcomes that can be separated from the use of the bench. The distinction between use, affordances, and outcomes is important both theoretically and methodologically when studying the affordances provided by the use of an IS.

In summary, affordance theory is a robust theoretical perspective adapted from the ecological psychology domain that offers different perspectives and levels of analysis for researchers to pursue. Building upon affordance theory, the NAF perspective provides a framework through which researchers can examine the drivers of the use of specific information technologies and the specific affordances enacted to fulfill those drivers.

The NAF view of affordances describes the relationship between an individual's needs, the affordance provided by the use of an IS, and the specific functionality of the IS (Karahanna et al. 2018). By identifying the drivers of the use of social media applications and the associated affordances, Karahanna et al. (2018) demonstrate the NAF model empirically. The overarching NAF model, visualized in Figure 3.1, demonstrates that an individual's needs drive the use of social media applications. Through the use of the different features of social media applications, the users enact different affordances. In turn, these affordances fulfill the needs that initially drove the use of social media.

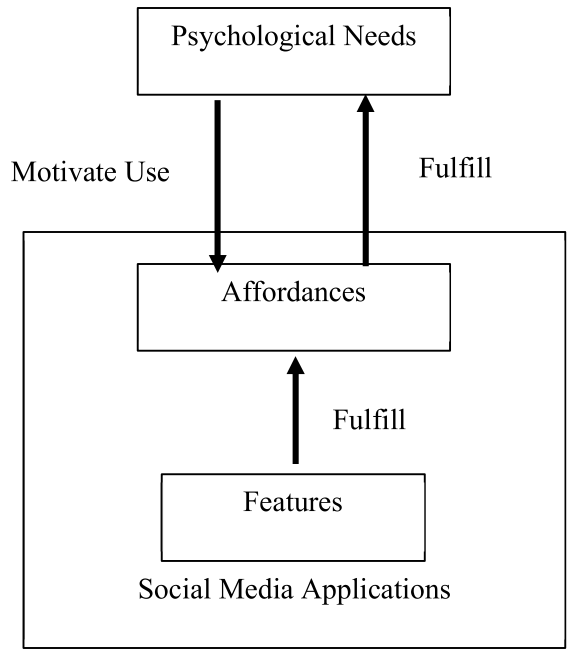

Figure 3.1. NAF Perspective (adapted from Karahanna et al. 2018)

There are numerous opportunities for extending the NAF model. First, there is the opportunity to identify affordances and drivers of use in different contexts and for different types of information systems (Karahanna et al. 2018). Second, although the early affordance literature does acknowledge that some affordances can be positive and others can be negative (Gibson 1977), the NAF model, and affordance theory in general, does not accommodate any tension between a user's goals, the actualized affordance, and the outcomes of the affordance. Recent IS literature lauds affordance theory as a robust lens for researchers to understand the choices people make concerning technology and the outcomes of those choices (Leidner et al. 2018), but stops short of examining both the positive and negative outcomes of specific affordances. Furthering the previous example of a hiker using a bench, what happens if there is an unknown fire ant bed beneath the bench or if the hiker suffers a painful splinter after sitting on the bench? How does that affect the affordances and their outcomes? The early affordance literature does not discuss the potential negative outcomes of an affordance, although it does allow for negative affordances (Gibson 1977). The IS literature does include a cursory discussion of how the current features of a technology can constrain the potential affordances (Leonardi 2011). However, this analysis happens at the organizational level where the features and functionality included in the technology can be more easily controlled, not the individual-level, where there is minimal control in what features and functionality are available from the developer. At the individual affordance level, one notable study discusses failures to actualize affordances (Benbunan-Fich 2019), but does not incorporate the outcomes of the affordance failure outside of failing to achieve the desired affordance. Because the NAF perspective and affordance theory do not accommodate any outcomes that are incongruent with the perceived affordances provided by an IS, there is an opportunity to further develop the theories. This study furthers the NAF model, and affordance theory, by examining both the drivers and outcomes of the enactment of perceived affordances. This study also examines what happens if there is a conflict between a perceived affordance and its outcomes. The next section describes the data and method used in this study.

CHAPTER FOUR

Data and Method

This study utilizes an exploratory, qualitative methodology to conduct a field study of the emotions involved and affordances utilized in the remote health monitoring of infants. This section describes the data and methods of analysis used in this study. I first show how previous researchers have used electronic word of mouth (eWOM) as a data source and briefly examine how others have studied emotions using eWOM. Next, I use the *Linguistic Inquiry and Word Count* (LIWC2015) software package to describe the data statistically and compare the data sources. Finally, in this section, I will outline the coding schema and methodology used in qualitatively analyzing the data.

Data Description

There are several reasons why conducting an exploratory analysis of user-generated reviews of an infant monitoring system is appropriate for studying the role of emotions, affordances, and outcomes in IS use. This justification is divided into methodology and context.

Concerning the methodology, eWOM has been used to study emotions in the IS discipline with several examples (e.g., Ba and Pavlou 2002; Yin et al. 2014). Most conventionally, emotions are a key construct when studying online reviews/comments and eWOM. Specifically, emotions have been studied in their effect on the perceived helpfulness of a review (Yin et al. 2014). This literature has shown that a negativity bias exists in the evaluation of eWOM. This negativity bias indicates that more negative reviews, including those with stronger negative emotions, have a stronger effect than positive reviews with individuals weighting negative reviews more than positive reviews when it comes to building trust in a product (Ba and Pavlou 2002) and helpfulness of the review (Kuan et al. 2015; Sen and Lerman 2007).

In addition to emotions, eWOM has been used as a data source when studying affordances within the IS literature. For example, Benbunan-Fich (2019) examines online reviews to identify the affordances associated with the use of a wearable IS. She conducted a qualitative analysis of a set of Amazon reviews collected by McAuley and Yang (2015) in order to show the affordances provided by a particular wearable IS, the Fitbit Flex (Benbunan-Fich 2019). This study demonstrates both the ability to use online reviews when identifying affordances and provides a methodology for analyzing the data.

In addition to eWOM as a source of data, infant monitoring is an excellent context in which to study emotions and affordances. As previously discussed, caring for an infant is one of the most stressful times for a family (Miller and Myers-Walls 1983). This stress serves to intensify the emotions experienced. Because of this stress and increased emotions, infant monitoring is an excellent context for studying the emotional drivers and outcomes of IS use. Overall, both eWOM as a source of data and infant monitoring as context are justifiably appropriate for this study.

Several steps were taken in order to collect a rich dataset for analysis. Reviews for the Owlet Smart Sock 2 were collected from two different sources. First, a script for the open-source statistical software, R, was written using the Rvest package to download 1,354 reviews of the Owlet Smart Sock 2 from Amazon. The reviews are dated from 11 July 2017 to the date they were collected, 24 September 2019. All of the reviews posted directly to the Owlet retail website, 1,207 in total, were also downloaded for analysis. The dates for the Owlet retail website reviews have an earlier date than the Amazon reviews with the date of the reviews ranging from 7 December 2015 to 20 September 2019. Interestingly, in the HTML code for the Owlet.com reviews, there were two dates, a date created and a date published. These dates differed by a day or two in most of the recent reviews. However, all reviews created 7 December to 21 March 2019 were not published until at least 21 March 2019. This discrepancy created over a year gap between when a review was created and when it was published. All reviews from both sources were used to provide a more robust perspective on the use of the infant monitoring system and to eliminate any potential biases that may exist in Amazon users versus those who purchased directly from the retailer's website. In contrast to Benbunan-Fich (2019), no limitation was set on the date or total word count of the reviews included in the dataset. In total, 2,561 online reviews comprised the dataset for analysis.

Additionally, several threads from two different Facebook groups were collected in order to ensure the content of the online reviews from both Amazon and the retail website were complete. This comparison between the Facebook comments and the online reviews was used to help verify that any biases from either Amazon reviewers or Owlet.com reviewers were not evident in the content of the comments of the review. One of the Facebook groups is a 16,000+ member, regional mom's group focused on provided crowdsourced advice and encouragement to mothers from a specific region in the southwestern United States. The second group consisted of 15,500+ members whose mission is to provide a positive environment for parents looking for advice and support in caring for their newborns. In all, seven threads and 180 comments were downloaded with all the initial posts in the threads being individuals asking for advice and other people's experiences regarding the Owlet Smart Sock. These social media posts were included to provide a different perspective of eWOM than the online reviews that formed the core of the source of data and to verify the reliability of the eWOM data.

In order to show the emotions present in the reviews and help decipher any differences between the sources of data, the *Linguistic Inquiry and Word Count* (LIWC2015) software package (Pennebaker et al. 2015) was used to help count the emotive words in each review. LIWC2015 uses a closed dictionary to count across 90 language dimensions. The descriptive statistics for all of the sources of data are shown in Table 3.1. The descriptive statistics for the Amazon reviews are shown in Table 3.2, for the reviews posted on the retail website are shown in Table 3.3, for the Facebook comments are shown in. Between the sources of data, there are no significant differences with the retail website reviews having slightly more variation in the percentage of affective words with that being driven by the larger variation in the percentage of words associated with positive emotions. This difference in variation might be due to the higher percentage of positive reviews on the retail website than Amazon. Table 3.5 shows the distribution of star ratings across each source of review and overall. The Amazon

Table 3.1. LIWC2015 Statistics for all Reviews and Comments, n=2741

Descriptive Stats	Total Word Count	% Affect	% Positive Emotion	% Negative Emotion	% Anxiety	% Anger	% Sad
Average	92.3	8.1%	6.3%	1.8%	0.9%	0.1%	0.3%
Median	66	6.5%	4.3%	1.3%	0.0%	0.0%	0.0%
Std. Dev.	95.4	8.5%	8.6%	2.2%	1.6%	0.5%	0.9%
Max	1125	100.0%	100.0%	25.0%	18.8%	11.1%	25.0%
Min	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.2. LIWC2015 Statistics for Amazon.com Reviews, n=1354

Descriptive Stats	Total Word Count	% Affect	% Positive Emotion	% Negative Emotion	% Anxiety	% Anger	% Sad
Average	94.1	8.9%	7.1%	1.8%	0.9%	0.1%	0.3%
Median	79	6.5%	4.4%	1.5%	0.1%	0.0%	0.0%
Std. Dev.	75.6	4.8%	4.7%	2.0%	1.4%	0.4%	0.7%
Max	444	100.0%	100.0%	18.8%	18.8%	5.9%	12.5%
Min	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.3. LIWC2015 Statistics for Owlet.com Reviews, n=1207

Descriptive Stats	Total Word Count	% Affect	% Positive Emotion	% Negative Emotion	% Anxiety	% Anger	% Sad
Average	98.6	7.2%	5.3%	1.8%	1.0%	0.1%	0.3%
Median	60	6.4%	4.3%	1.2%	0.0%	0.0%	0.0%
Std. Dev.	113	10.5%	10.7%	2.3%	1.6%	0.5%	0.8%
Max	1125	100.0%	100.0%	21.4%	16.7%	11.1%	12.5%
Min	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.4. LIWC2015 Statistics for Facebook Comments, n=180

Descriptive Stats	Total Word Count	% Affect	% Positive Emotion	% Negative Emotion	% Anxiety	% Anger	% Sad
Average	36.8	8.3%	6.7%	1.5%	0.9%	0.1%	0.3%
Median	29	6.7%	3.7%	0.0%	0.0%	0.0%	0.0%
Std. Dev.	31.6	9.7%	9.9%	2.8%	1.7%	0.5%	2.0%
Max	220	75.0%	75.0%	25.0%	9.1%	6.3%	25.0%
Min	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 3.5. Star Ratings for All Reviews

Review Source	Avg Star Rating	% 5-Star Ratings	% 4-Star Ratings	% 3-Star Ratings	% 2-Star Ratings	% 1-Star Ratings
Amazon	3.99	63.7%	8.9%	5.8%	5.8%	15.9%
Owlet	4.48	71.7%	16.2%	4.5%	3.6%	4.0%
Overall	4.22	67.5%	12.3%	5.2%	4.8%	10.3%

reviews, on average, have a lower star rating with a lower percentage of 5-star reviews and a higher percentage of 1-star reviews than the reviews posted to the Owlet webpage.

The sources of reviews are similar with respect to the word count of each review and the percentage of emotion-laden words as revealed by LIWC2015. However, the owlet reviews tend to lean more positively with a higher proportion of 5-star ratings and broader distribution of words associated with positive emotions. Although there are some minor differences between the Amazon and Owlet.com reviews, the data from both of the sources appear to be relatively similar.

Coding Schema and Methodology

In analyzing the data, I followed an open, selective, and theoretical coding process (Glaser 1978; Urquhart 2012). In the open coding stage, the data drove the coding process. I freely coded each review based on how the reviewer felt about the technology, why they said they started using the technology, why the reviewer liked using the technology, or why the reviewer did not like the technology. In the selective coding stage, I scaled the open codes into several themes related to the research question. The selective codes are related to the drivers of the IS use, the perceived affordances provided by the technology, and the outcomes of using the technology. Both the open and selective codes are detailed in the appendix. Finally, in the theoretical coding stage, I coded the relationships between the revealed themes and constructs. Throughout the coding process, I was in constant comparison with the data similarly coded. This constant comparison enabled me to ensure that I correctly understood and categorized each piece of datum. Using a bottom-up data analysis approach, allowed me to be immersed in the data without any *a priori* theoretical leanings. The underlying theoretical structure was revealed through the data. By returning to the literature following both the open and selective coding, I was able to derive the theoretical codes and relationships simultaneously through the literature and data.

In summary, the context, data, and methodology for the study are appropriate for the research question. The emotionally-charged nature of caring for a newborn makes the study of emotions in the context justifiable. The efficacy of utilizing eWOM and online reviews to study both emotions and affordances has been demonstrated in the literature. Finally, the exploratory, qualitative nature of the study is proper for the open nature of the research being conducted. The flexible coding process allowed me to stay immersed in the data while continuously comparing it to the extant literature. In the next section, I discuss my analysis and findings.

CHAPTER FIVE

Analysis and Findings

This chapter presents findings that the analysis of the data revealed. Before presenting the findings, it is essential to discuss the infant monitoring system reviewed in the data, how it operates, and its specific features. To organize the findings, I present the affordances, constraints, drivers of use, and outcomes identified through the analysis of the data. Each of these constructs is divided into emotional, behavioral, and physical. Using these constructs, I further the NAF model to include both constraints and outcomes. Finally, I present several major findings theorizing the relationships between the drivers of use and affordances and the relationships between the affordances and constraints based on their related outcomes.

Owlet Smart Sock 2 Description

The Owlet Smart Sock 2 is an infant monitoring system that allows for the remote monitoring of an infant's health status. The system consists of three separate components, the sock, the base station, and a mobile application. Figure 5.1 visually depicts the three components of the IMS. The sock is not a sock in the traditional sense of the word, but a sensor that uses a hook and loop fastener to hold itself to the infant's foot. The sensor measures both the infant's heart rate and oxygen saturation in real-time. The sock transmits the data to the base station via a Bluetooth connection. The base station monitors the infant's heart rate and oxygen saturation it receives from the sock. If they fall out of limits, below 60 beats per minute, above 220 beats per minute or below 80 percent oxygen saturation, the IMS sounds an alarm. If the health stats are within limits, a green light glows and pulses from the base station. If the base station loses Bluetooth connection with the sock, a blue light glows while an audible lullaby plays to alert the user to the lost connection. A signal is sent to the base station if the sensor shifts or falls off the infant's foot so that it cannot achieve a proper reading. A yellow light then pulses while an audible lullaby plays from the base station. While the system requires a WiFi connection for the initial setup, a WiFi connection is not required for the operation just described.

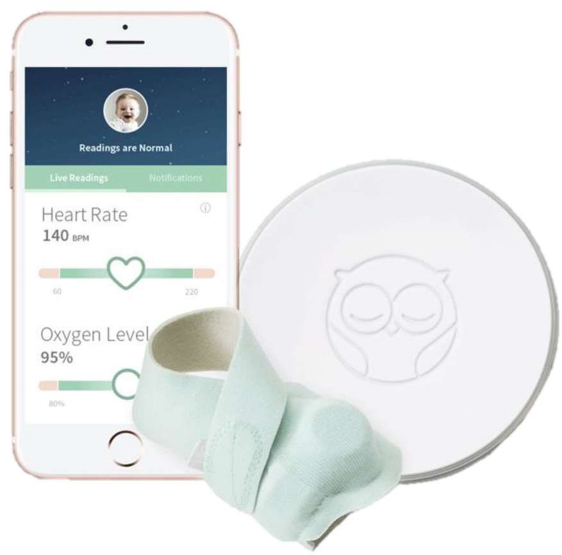

Figure 5.1. Owlet Smart Sock Infant Monitoring System (*Owlet Smart Sock* n.d.)

If there is a WiFi connection, the third component of the system is functional. The mobile application displays real-time health statistics and long-term trends. The real-time statistics in the mobile application show both the current heart rate and oxygen saturation. Based on the heart rate and oxygen statistics, the application tracks the infant's sleep cycles and display the infant's sleep trends. Similar to the base station, the application pushes a notification if the health statistics fall out of the predefined limits, the base station loses Bluetooth connection, or if the sensor in the sock becomes misplaced. Additionally, the mobile application pushes a notification if the base station loses WiFi connection. The features of the three components are displayed in Table 5.1.

Table 5.1. Features of Owlet Smart Sock 2

Feature Name	Description
Green Light	The green light that glows from the base station when heart rate and oxygen saturation is within limits
Yellow/Blue Alarm (Visual)	The yellow or blue light that glows from base stations when there is a sensor placement (yellow alarm) or connectivity issue (blue alarm)
Yellow/Blue Alarm (Audio)	The lullaby that plays from the base station stations when there is a connectivity or sensor issue
Yellow/Blue Alarm (Mobile)	Notification on the mobile application when there is a connectivity or sensor issue (base station disconnects, WIFI disconnects, sock falls off, infant wiggling)
Red Alarm (Visual)	The red light that glows from the base station when heart rate and oxygen saturation is out limits
Red Alarm (Audio)	The alarm that sounds from the base station when heart rate and oxygen saturation is out limits
Red Alarm (Mobile)	Notification on the mobile application when heart rate and oxygen saturation is out limits
Real-Time Vitals	Current heart rate and oxygen saturation displayed on the mobile application
Historical Tracking	Heart rate and oxygen saturation trends synthesized into sleep tracking via the mobile application

Overarching Model

While the findings of this study are presented in a linear format, they were revealed through a non-linear analysis of the data in conjunction with constant comparison with the extant literature. Figure 5.2 is the final model developed from the analysis. The features, use, and affordances are the same as appropriated in the NAF perspective. Not shown in Figure 5.2 are the drivers and needs that are fulfilled by the affordances provided by the IS. The model flows out of the features offered by the IS Table 5.1 as it is the use of these features that creates the opportunity for the enaction of several affordances. At the same time, the use of the features of the technology also results in several constraints that exist in tension with the affordances. The affordances result in several positive and negative outcomes. The constraints result in several negative outcomes. These positive and negative outcomes all exist in conflict with each other. Depending on the result of the tensions between the affordances and constraints, the affordances motivate the continued use of the IS. In parallel, the constraints, from the designer's perspective, lead to the development of new technology features. Finally, not shown in Figure 5.2, are the drivers of initial use. As explained through the NAF

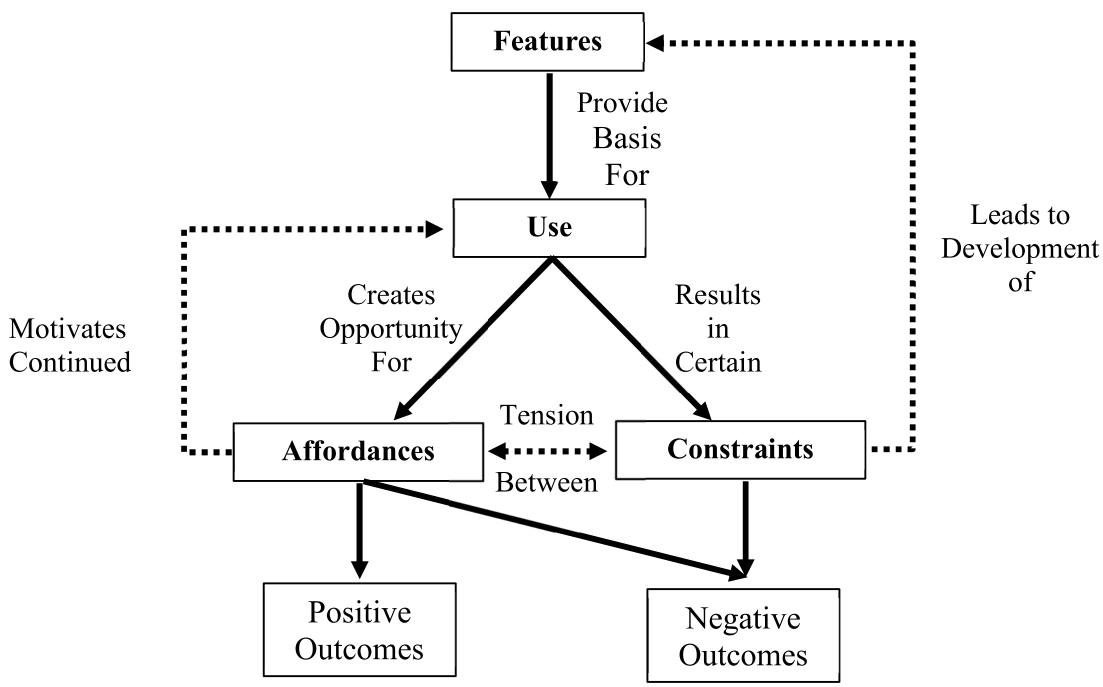

Figure 5.2. Affordance-Constraint-Outcome Model

perspective, that this model is both derived from and builds upon, the drivers motivate IS use and the affordances provided through the use of the IS fulfill the needs that motivated the initial use.

The findings can be divided into the front-end and back-end of the use of the IMS. The front-end consists of the drivers that lead to a parent choosing to use the IS. The back-end consists of the affordances and constraints that arise out of the use of the features of the technology. Each of the individual constructs is sub-divided and categorized by emotional, behavioral, and physical. For example, there are emotional, behavioral, and physical drivers of use and emotional, physical, and behavioral outcomes. Starting with the affordances and constraints that result from the use of the IMS, I will describe each of the constructs that were revealed from the data.

Affordances of IMS Use

The affordances provided by the use of IMS features can be divided into emotional and behavioral affordances. From the user perspective, because affordances are a relationship between the goals of the user and the features provided by the IS, there are no physical affordances. This is because of the conceptual separation of use and affordances. A physical affordance provided by an IS would simply be the physical use of the IS. I will now explain the affordances provided by the IMS and describe the features that enable the affordances.

Emotional Affordances

There are two emotional affordances provided by the IMS, reassurance and satisfying. Table 5.2 provides the definitions for the emotional affordances. Reassurance is the affordance provided by the green light feature of the IMS base station. This "green glow" is a visual reassurance that the infant's heart rate and oxygen saturation is within healthy limits. Instead of having to get up and check on the child, the IMS monitors the child continuously. As an IMS user puts it, "That glowing green light is the most reassuring sight." The reassurance provided by the IMS, through the glowing, green light, assures the parent that the infant is alive and healthy.

The second emotional affordance is satisfying. The ability to check the infant's vital signs in real-time through the mobile application satisfies the urge to know the infant's precise heart rate and oxygen saturation. A parent who was separated from their infant described the satisfying affordance, "I was hospitalized for a few days, and being away from my baby was hard, but being able to look at the app to check his stats gave me piece of mind." The feature that allows this affordance is the base station wirelessly connected to the mobile application. By checking their phones, parents can satisfy the desire to know the infant's real-time vital signs.

Table 5.2. Emotional Affordances

Affordance	Definition	Example Features
Reassurance (EA1)	Enable assurance of infant's well-being	Green light that glows on base station
Satisfying (EA2)	Instant awareness of infant's vital signs (heart rate and oxygen saturation) whenever caregiver desires	Real-time tracking of vital signs via mobile app

Behavioral Affordances

Two behavioral affordances are evident in the data. Table 5.3 provides the definitions for the two behavioral affordances. The first affordance is related to the freedom the users of the IMS have to do other activities other than continuously checking

Table 5.3. Behavioral Affordances

Affordance	Definition	Example Features
Freedom	Provides freedom of caregiver to do other things than continuously check on infant	Bluetooth and WiFi connectivity enables unlimited distance between infant and caregiver while maintaining K1, K2, K3
Reaction	Provides the caregiver the ability to instantly react whenever there is a breakdown in the well-being of the infant	Red alarms via base station and mobile app

on the infant. Because the IMS is "watching" the infant, the caregivers can focus on other tasks, whether it is watching other children, doing household chores, or simply relaxing. The freedom affordance was described by a parent in this manner, "It allowed me the freedom to sleep, shower, and do things around the house instead of hovering over our little one just to make sure they're breathing." The Bluetooth connectivity of the sock to the base station and the WiFi from the base station to the mobile app allows for unlimited distance between the infant and caregiver. Contrary to the freedom affordance, the second affordance is reaction. This behavioral affordance of the IMS allows the caregiver to react if there are any issues with the infant's heartbeat or oxygen saturation levels. The loud red alarm through both the base station and mobile apps instantly alerts the caregiver allowing him/her to react and provide any necessary care. A caregiver explained the reaction affordance, "We love the piece[1] of mind knowing if her oxygen or heart rate drops or rises above a certain level, we will be notified!" The goals that lead to the reaction affordance are derived from the caregivers' desire to be instantly alerted if something happens to the infant. The goal is not that the caregiver would have to react to

[1] All typographical and grammatical errors in the data were left in their original form to show the full context of the review. Sic and other conventional ways to show the errors are not used by the author to help improve readability.

a breakdown in the infant's health but that the IMS is there to alert so that a reaction is possible.

Physical Affordances

There were no physical affordances identified in the data. There are several reasons. First, due to the conceptual and methodological separation of use, affordances, and outcomes prescribed by Leidner et al. (2018), there was no separation between a physical affordance and the use of the IMS. Observing the infant's health statistics on the mobile application is not a physical affordance; it is the use of the IS. Installing the system is not a physical affordance; it is use. Second, many of the physical aspects that resulted from the use of the IMS actually constrained and limited the enactment of the previously identified affordances. Thus, I conceptualize constraints that exist in tension with the affordances provided by the use of the IMS.

Constraints of IMS Use

The constraints that arise from the use of the IMS are separate from the affordances. While affordances exist between the goals of the user and the features of the technology, constraints exist solely as a function of the features or limitations of the features of the IS. However, just like affordances, constraints are not the use of the technology or only bugs or limitations of the technology. They do arise out of the use of the technology, but are conceptually separate from use and any negative outcomes of use. Emotional, behavioral, and physical constraints were all identified during the analysis of the data. I first will describe the emotional constraints.

Emotional Constraints

One emotional constraint was readily apparent in the data. This constraint is the uncertainty that arises from the use of the system. Table 5.4 gives the definition and example features of the uncertainty constraint. Some features or shortcomings of the IMS create additional unknowns for the users of the system. Specifically, the yellow and blue alarms, false positive alarms, and privacy concerns with the WiFi connectivity have the potential to create a sense of uncertainty when using the IMS. A reviewer depicted an aspect of the uncertainty that occurs when the IMS sensor cannot get a reading because the infant is moving, "What if baby is struggling to breathe because they moved their head or something and they are wiggling? You won't know an issue is occurring until the movement STOPS." Uncertainty exists in conflict with the reassurance, freedom, and reaction affordances the users desire.

Table 5.4. Emotional Constraints of IMS Use

Constraint	Definition	Example Features
Uncertainty	The concept where features and/or shortcomings of the information system create additional unknowns with the user	Yellow Alarms, Blue Alarms, False Positive Alarms, Privacy Concerns

Behavioral Constraints

The behavioral constraints that can arise from using the IMS are a learning curve and conditioning to the data. The definitions and example features of the behavioral constraints are given in Table 5.5. The learning curve arises from both learning how to set up and initially use the IMS and learning how to prevent non-true positive alarms. The learning curve associated with installing and setting up the system conflicts with plug-and-play expectations. The limitations associated with the Bluetooth connection between the sock and the base station makes some parents have to experiment with different locations to keep the base station connected. Once the system is initially installed, parents realize they have to learn how to attach the sock and sensor properly to the infant to get an accurate reading. All of the different ways that parents have to adjust how they use the technology in order for it to operate as expected add up to the learning curve constraint. In describing the process in getting the IMS to work properly, an online reviewer perfectly described the learning curve constraint,

> I will be honest, it was hard to figure everything out at first, the WiFi connectivity and the tightness of the sock fitment. These things greatly affect the functionality of this product and the frustration from sleep deprived parents. On my first night I thought this thing was junk, but as I calmed down and readjusted everything, on my second night everything worked as it should and the sock wasn't coming off (which would constantly alert you through the night) Quick tip: put a regular sock on top of Smart Sock to have it secured even better! Highly recommend this product if you take your time to set it up during the day so it's ready for the night!

The learning curve constraint exists in tension with the reassurance affordance by not allowing the affordance to be enacted until a certain level of learning has occurred. The constraint is in conflict with the satisfying affordance in that until the base station is continuously connected to the internet through a wireless connection, there is no way to tell an infant's precise vital signs using the IMS. Finally, the learning curve constraint conflicts with the freedom affordance due to the Bluetooth connection's distance

Table 5.5. Behavioral Constraints of IMS Use

Constraint	Definition	Example Features
Learning Curve	Users efforts to adapt to technology in order to minimize other constraints	Initial setup, how to prevent yellow and false alarms
Conditioning to Data	Once a user is exposed to the benefits of the technology, the user cannot see themselves stopping using the technology or experiences more severe negative outcomes if the technology is removed	Live stream of data via both mobile apps Green glow of base station

limitations. Parents realize that their freedom is limited to the short distance required for the Bluetooth of the sock and base station to stay connected without a WiFi connection. All of these factors lead to the learning curve behavioral constraint of having to adapt to using the IMS to minimize the other constraints.

The second behavioral constraint is the conditioning to the data. Similar to the behavioral driver of previous data conditioning, this behavioral constraint arises from the constant exposure to the IMS benefits. Once the parents are conditioned to know the infant's vital signs anytime, it is difficult for them to imagine not having that access anymore. Once they are used to the reassurance provided by the green glow of the base station, they do not want to give that reassurance up, even to the point of wanting to have a backup IMS to use at other locations, as one parent conditioned to the data described, "My only complaint is that I want MORE of it. Including a second set of electronics for those 'oh no!' Moments, and providing a smaller, portable base station to bring to daycare, grandmas house, etc. would be so ideal and convenient!" This behavioral constraint, as described, contradicts both the reassurance and satisfying emotional affordances in that once those affordances are actualized, the parents are conditioned to that emotional affordance. They can no longer do without the affordance.

Physical Constraints

The physical constraints are the limiting factors associated with either the performance or design of the IMS. Table 5.6 defines the reliability and design constraints. Reliability, as the first physical constraint, arises from issues with the technology not performing as intended. There are a myriad of reliability issues that users identified in the data, the most common of which are related to either battery life or charging issues.

Many users complained that that battery ceased lasting as long after several months of use or simply would not charge anymore. The reliability of the battery and charger affected the user's ability to actualize the desired affordances. Describing the reliability issues with the charger, an IMS user wrote this,

> As some others have also posted, the sock's internal connector seems to have quality issues in that after close to a month, the internal charging connector on the sock broke (you can see a bent pin on the inside). Thus the sock wouldn't charge and the sock became useless.

Other factors that lead to the reliability constraint is the mobile application issues arising from WiFi connectivity. Several users commented on the base station disconnecting from WiFi leading to the mobile application becoming unusable. Additionally, the sensor in the sock appeared to have reliability issues, with many users commenting on how they had to pay to replace the sensor after it stopped working correctly.

The design physical constraint is similar to the reliability in that it is related to the IMS performance. However, it differs from the reliability in that the design constraint is how the intended performance does not meet the user's expectations. One primary factor leading to the design constraint is that the IMS does not have custom alarm levels. Thus, the parents cannot establish the limits where the system will alarm. They are stuck with the limits set by the manufacturer. Some users noticed that the limits are either lower or

Table 5.6. Physical Constraints of IMS Use

Constraint	Definition	Example Features
Reliability	Issues with the IS not performing as intended	Charging issues, poor battery life, mobile app issues, hardware breakage
Design)	Issues with the intended performance not meeting expectations	Poor mobile app performance, no custom alarm levels, limited Bluetooth range, poor fit of sock

higher than they are comfortable. One reviewer portrayed this aspect of the design constraint in their review,

> The first flaw I found with the smart sock was that it won't red alarm until your baby's oxygen level is below 80%. They're already losing brain cells at that level. We kept using it anyways because something was better for peace of mind than nothing.

Others commented on the difficulty in getting the sock to fit the infant properly, causing many unwanted yellow alarms. Earlier commenters commented on the IMS required a monthly payment to access the historical data. Later, the complaints shifted to needing a second mobile application to view historical trends. All of these physical constraints, whether reliability or design, directly affected the user's ability to enjoy the desired affordances.

Some parents were able to overcome the constraints, while others were not and ceased using the IMS. For example, the following reviewer described overcoming the learning curve constraint by experimenting with putting a sock over the sensor on the infant's foot to prevent yellow alarms,

> We were loving the owlet for the first few months but then suddenly we were getting multiple false alarms a night. After a ton of research we found out if your baby's foot gets too cold, it will cause false alarms. Now what we do is take an adult sock and put it over the baby's foot that is wearing the owlet. No false alarms since doing this!

Other reviewers spoke of not being able to overcome the constraints and gave up using the IMS. Having been completely frustrated by both the design and reliability constraints of the IMS, this user described why they returned the device,

> With the intention of a better night's sleep resting assured that the Owlet would be an electronic guardian angel, I was quickly proven wrong. The first night we used it, after setting it up and charging the sock for 6 hours, it worked great. It's only going to work when the baby is SOUND asleep -Any movement cancels any and all readings the monitor takes and reports to the app. Our baby slept well and the

> unit worked perfect the first night. The second night we used it, the sock lost connection with the base (only about 4 feet away from each other) which scared the daylights out of us waking up to the advisory music playing. After reconnecting in the middle of the night and getting the baby to fall back asleep from the alarm, it worked again. The third night, the base disconnected again twice for no apparent reason even after checking sock placement, etc. For $300, this system should be much more reliable. We've started the return process with Amazon and I simply cannot recommend this to anyone

Because of the tension between the perceived affordances and the constraints, the constraints can either overwhelm the user and lead to discontinued use of the IMS or, as described, the user is able to overcome the constraints and actualize the affordances of the IMS.

Drivers of Infant Monitoring

Emotional Drivers

From the data, several factors were identified that drove a parent's use of the IMS. These emotional, behavioral, or physical factors were identified as being the primary drivers motivating the IMS use. As previously noted, the stress and the emotions experienced during the early days and weeks of caring for a new infant are incredibly high. This emotionally charged environment leads to three emotional drivers motivating the use of the IMS. These emotional drivers can generally be described as negative valence and positive arousal emotions that fall into the upper left quadrant of Figure 2.3.

These emotions that drive the use of the IMS are fear, anxiety, and guilt. Table 5.7 provides an overview and definitions of these three emotional drivers. As emotions are an affective response to a stimulus (Stein et al. 2015), I identify the stimulus for each of the emotional drivers revealed in the data.

Table 5.7. Emotional Drivers of IMS Use

Emotional Driver	Definition	Primary Affordance	Representative Example from Data
Fear	A rational or irrational fear of something happening to the infant that the parent cannot control	Reassurance Satisfying Reaction	"We have a phobia of SIDS and have a habit of checking many times throughout the night if Baby is breathing." "As a new mom I was not sleeping because I was so scared that my baby was juat* going to stop breathing at night"
Anxiety	Heightened levels of stress due to the additional requirements of caring for a newborn infant, usually while the infant sleeps	Reassurance Satisfying	"Although I am a nurse, I had terrible anxiety after bringing my baby home." "My anxiety of having a baby, especially a preemie, would overwhelm me if it weren't for this device."
Mom Guilt	The strong desire to do everything possible to provide the best care of a parent's infant	Reassurance Freedom Reaction	"I would pay anything to keep my baby safe." "Knowing what I know, and that the Owlet gives me options, I would feel guilty NOT to use one"

*Note: All quotations in the data presented in the text or tables are unedited. Thus, all typographical and grammatical errors are left in their original form to show full context of the review. "Sic" and other conventional ways to demonstrate errors are not used by the author to help improve readability

The most commonly cited emotion involved in the decision to purchase the IMS was a rational or irrational fear of something negative happening to the infant that the parent cannot control. This fear primarily manifested as the anticipatory reaction to the possibility that the infant might succumb to SIDS. As one reviewer put it, "We have a phobia of SIDS and have a habit of checking many times throughout the night if Baby is breathing." Another family having experienced SIDS previously, understanding that the technology does not prevent SIDS, explained their fear this way,

> My grandma lost a child to SIDS, so it had always been a huge fear of mine. It doesn't prevent SIDS but it will alarm you immediately if the oxygen levels drop

> below normal or the heart rate is below normal or too high meaning distress, which can give you the seconds you need for live saving actions.

As shown in the data, this anticipatory emotion is a reaction to the possibility of SIDS or stimulated by a general fear of the syndrome. Another fear, other than a fear of SIDS, is a fear that something might happen while away from the infant. A user's mother-in-law felt so strongly about her daughter-in-law's emotions that she wrote, "My daughter-in-law is so afraid of leaving their baby alone that this was such a blessing." This fear might arise while a parent is away at work and fears something might happen when they are not home, as one reviewer expressed, "I bought the owlet when I started working nights to help ease my mind about me not being home with my three month old." Also included is the fear motivated by a parent's past experiences, specifically those who have previously lost a child. Having experienced or knowing someone who experienced a previous loss, these parents are fearful that something similar might happen to their so-called rainbow baby. Rainbow babies are the subsequent infant born after a miscarriage, still-birth, other type of loss. Parents of rainbow babies are more likely to experience strong feelings of anxiety or fear (Chertoff 2018). Many users described the painful loss of a previous child, followed by a debilitating fear that it could happen to their new infant. As one parent described, "My rainbow baby has worn his Owlet Smart Sock since the day he was born. After losing his older brother to SIDS the year before we were terrified." A previous loss during pregnancy multiplied by other medical complications can also stimulate this fear. A mom who suffered a stillbirth at 28-weeks pregnant and whose new infant spent time in the neonatal intensive care unit (NICU), described her fear and process of using the IMS this way,

> After a heart breaking loss at 28 weeks during my first pregnancy, this one made both my husband and I extremely nervous. I mentioned this product to my husband and he immediately wanted it. We got through delivery, but discovered a large hernia that had to be operated on. After 4 nights in the NICU (with constant monitoring), we were crazy nervous about bringing home our little bundle of joy. The Owlet allowed a drained mama and papa get some peace of mind and both got some sleep!

These fears can be generally defined as a fear that something negative might happen to the infant out of control of the parents. It is stimulated as an anticipatory reaction to potential adverse events. As described, it can be a fear of something specific like SIDS or the infant stopping breathing or fear that some unknown, negative might occur with the infant's health.

Anxiety is another emotion often cited as motivating the decision to purchase the IMS. This anxiety is heightened due to the many unknowns and additional requirements in caring for a newborn. It can be a reaction to the current health status of the infant. A reviewer described it this way, "my anxiety of having a baby, especially a preemie, would overwhelm me if it weren't for this device." This anxiety occurs mostly with the parent worrying about the infant's health status while the infant sleeps. One parent stated that she purchased the IMS because she was "constantly waking up to check if she [the baby] was breathing, feeling her pulse, etc. I was a nervous wreck. I was hesitant to spend $300 on this product, but decided to give it a try." Another mom described it this way,

> Like every new mom I expected anxiety with my newborn. I never thought just how nervous I would be at night. I barely slept the first few weeks, even though he was sleeping well, I constantly needed to sit up and look in his sleeper to make sure he was breathing. I asked a friend who used an owlet how they liked it and upon their recommendation purchased my own.

While the anxiety previously described is related to the fear experienced, it is the fear of the unknown that is driving the anxiety. Some of the anxiety driving the use of the IMS is not anticipatory but experienced within the impact period of a non-IS event. Much of the anxiety is stimulated by either a prior health scare or the current known health status of the infant. One reviewer whose doctor recommended not using an IMS wrote this:

> Doctors told us that these not needed and sent us home from NICU without monitors also girls being born at 29 weeks and came home 3 weeks before do date at 4lbs..we ended up having one of our girls stop breathing. Thankfully we were paying attention at the time. After that scare we found it nessasary to get the owlets as it would have caught that if we weren't paying attention.

The anxiety driving the use of the IMS can be either anticipatory in nature or during the impact period of a non-IS stimulus. The anticipatory anxiety is stimulated by a future, uncontrollable event, whether it be the anticipation of an unknown health issue with the infant or that something might go wrong that could have been prevented. Other individual's IMS use is driven by an anxiety that is occurring during the impact period of the stimulus, not in anticipation of a stimulus. This impact period anxiety typically occurs due to a known health issue with the infant. This health issue can be a prior medical diagnosis or the increased fragility of an infant that is born prematurely.

The final emotion that drives the use of the technology is the guilt parents feel when they do not believe they are being the best parents possible. I use the colloquial phrase mom guilt to describe this emotion. The mom guilt is stimulated by the perceived peer pressure to do everything possible to provide the best care for an infant. To avoid this feeling of a guilt, everything must be done to keep the infant safe and comfortable, no matter the cost. As one reviewer described, "Price is high BUT worth the cost of preventing the loss of my baby." Another new mom described her willingness to do anything for the safety of her baby this way, "As a new, young mother I'm willing to try anything to make sure my baby is safe. I believe the Owlet is a life saver." Finally, this peer pressure generated mom guilt was evident in the way reviewers described their own horrific experiences and strongly urged other mothers to purchase the IMS to reduce the potential of tragically losing their infant like this reviewer,

> It saved our sons life. (2 months old) One evening, during his sleep his oxygen and heart rate dropped. He wasn't but two feet away from me while I was working on a diaper cake for my sister-in-law's baby shower. He was so peaceful. The only reason it was not SIDS, is because he didn't die, the owlet monitor alarmed me immediately, giving me enough time to take action to save him. It landed us a hospital stay. I beg, beg, beg mothers to buy this. $300 is nothing compared to their priceless life.

This online review demonstrates the power of the guilt a parent can feel to do anything to help them feel that their infant is safe and healthy. To avoid this guilt, parents choose to use any tool at their disposal to protect their infant's health and safety.

The most common emotional drivers motivating the use of the IMS are fear, anxiety, and mom guilt. While there is a wide variety in what is stimulating these emotions, in general, the emotions are stimulated by a strong parental desire to do what is best for the infant and the struggle to cope with the unknown. Whether the fear or anxiety is driven by the unknowns of SIDS, the fragility of an infant's health, or not being viewed as the best parent possible for the infant, it is readily apparent that emotions are a powerful motivator in the use of IMS. Next, I will present the behavioral drivers of the use of the IMS.

Behavioral Drivers

Three behavioral drivers motivate the use of the IMS: caregiver sleep issues, infant sleep issues, and prior conditioning to health data. While the online reviewers cite these three behavioral drivers directly as motivating the use of the IMS, they are also inter-related with both the emotional and physical drivers. For each of the behavioral drivers, Table 5.8 defines, gives the related affordances, and gives examples from the data. The parent's sleep, or the lack thereof, is the first behavioral driver of IMS use. Simply put, parents buy the IMS because they are not sleeping well with a new infant in the house and believe the IS will help them sleep. As a parent stated, "After a week of not sleeping while our newborn slept, we made this purchase and have slept when baby sleeps ever since."

Table 5.8. Behavioral Drivers of IMS Use

Driver	Definition	Primary Affordance	Representative Example from Data
Caregiver Sleep Issues	Parent does not sleep due to emotional issues or continually having to check on the infant physically	Reassurance Satisfying	"After a week of not sleeping while our newborn slept, we made this purchase and have slept when baby sleeps ever since."
Infant Sleep Issues	Infant will only sleep in a way that motivates emotional drivers such as rolling over, sleeping on belly, or sleeping noisily	Reassurance Reaction	"Just got the sock for our 4 month old because he is now ready to flip to his belly which scares us because he's not great at lifting his head." "My son ended up being a stomach sleeper, so I couldn't use it and my anxiety about him sleeping kept getting worse and worse. I wasn't sleeping; just watching him breathe. Finally, I decided to just buy the owlet."
Already Conditioned to data	Parent is conditioned to the data from NICU or hospital	Satisfying	"My baby spent a month in the NICU and I knew I would go crazy not being able to see her vitals in numbers once we got home."

Despite the simplicity of a parent's need for more sleep when caring for a newborn, the exact reasons for the lack of sleep are more nuanced. One reason for the caregiver's sleep issues is that the caregiver is continually checking on the infant while the infant sleeps. One user described it this way,

> When my son was born I would obsessively check him to make sure he was breathing. If I'd wake before he woke me to nurse at night I'd frantically tear him out of bed to make sure he was okay. I was a mess! At 3 weeks old I finally caved and spent the money (it was NOT in our budget) for an Owlet.

This constant checking is primarily motivated by a fear for the infant's health or anxiety that something might happen while the parent is sleeping, two of the emotional drivers. Representative of those whose sleep is interrupted by anxiety, this user explained the IMS purchase,

> I was having a hard time sleeping at night when we brought our 2nd home from the hospital because I was so worried something would happen while I was sleeping. My anxiety got pretty bad, so we finally decided to buy Owlet.

While the caregiver's lack of sleep is an obvious behavioral driver of the choice to use the IMS, a more nuanced-view reveals the relationship between the emotional drivers and the caregiver's lack of sleep.

In addition to the caregiver sleep issues, infant sleep issues are a behavioral driver motivating IMS use. The infant sleep issues are manifested through the infant rolling over while sleeping, refusing to sleep on their back per physician recommendations, or simply being a noisy sleeper. While the caregiver sleep issues are motivated by emotional drivers, the infant sleep issues motivate emotional drivers. Representative of this type of driver, one user explained their purchase, "My son ended up being a stomach sleeper…and my anxiety about him sleeping kept getting worse and worse. I wasn't sleeping; just watching him breathe. Finally, I decided to just buy the owlet." The infant rolling over is a behavioral milestone that motivated the purchase. One user explained, "Once my son started rolling over I was freaking out in the middle of the night when he would lay with his head face down. I was losing too much sleep so I bought this."

The final behavioral driver is the parent's previous conditioning to a constant stream of the infant's health data. By being conditioned to the continuous stream of health data provided by remote monitoring, the parents cannot imagine living without the data. This prior conditioning primarily occurs when the infant is tiny and fragile in either the NICU immediately following the birth or a hospital stay soon after birth. Online review after online review spoke of how comfortable they were with the monitoring at the hospital and how they were scared to go home without the monitoring. A great example of this is a parent describing a hospital stay motivating their purchase of the IMS, "Our 1 month old son contracted RSV and had to be rushed to the ER for respiratory distress. Upon discharge I was terrified to go home and not know what his oxygen levels were. So we purchased the Owlet." Another mother depicted the data conditioning this way,

> I am the mother of a micro preemie. I bought the owlet because after her being on monitors 24/7 for three months in the NICU, knowing what her oxygen level and heartrate were at all times became a security blanket. I always knew how she was doing.

The conditioning to the data is a behavioral driver the tends to exasperate the emotional drivers, specifically fear and anxiety. The previous examples and many others in the data speak to the parent's increased anxiety of the unknown due to not having access to the health data or fear of something happening when not being monitored. These sleep issues, both caregiver and infant, and data conditioning are behavioral drivers that, when combined with the previously described emotional drivers, motivate the use of the IMS. While the behavioral drivers are separate from the emotional drivers, they are linked in that the behavioral drivers greatly increase the emotions experienced. Next, I will describe the physical drivers of the use of the IMS.

Physical Drivers

The physical drivers of the use of the IMS include a medical condition already existing in the infant, the premature birth of the infant, and the transitioning of the infant when reaching developmental milestones. The physical drivers are medical and developmental factors that play a role in motivating the IMS use. Table 5.9 provides the definition and examples from the data for each of the physical drivers. Like behavioral drivers, while the physical drivers are interconnected with the behavioral and emotional drivers in motivating the use of the IMS, each of the physical drivers is distinct and exists independently.

The first physical driver motivating IMS use is the presence of a prior medical condition in the infant. The medical condition typically requires a hospital stay or at least a visit to the physician to receive an official diagnosis. Most of the pre-existing conditions were discovered immediately postpartum and required a stay in the NICU. One mother described her son's NICU stay and the reasons for purchasing the IMS,

> When our son was born he asperaited a little and had to spend time in NICU. This broke my heart and scared me so much. He was cleared with a clean bill of health but my husband knowing me bought this for us to have when we took him home.

Other infants have been diagnosed with either an acute or chronic condition that instigated the IMS purchase and use. Many of these conditions are related to the infant's respiratory or cardiac system, hence the desire to remotely monitor their heart rate and

Table 5.9. Physical Drivers of IMS Use

Driver	Definition	Primary Affordance	Representative Example from Data
Pre-existing Condition	A pre-existing or previous medical condition already necessitated a hospital stay	Reassurance Satisfying Reaction	"When our son was born he asperaited a little and had to spend time in NICU. This broke my heart and scared me so much. He was cleared with a clean bill of health but my husband knowing me bought this for us to have when we took him home." "I bought this after my daughter contracted RSV at only two weeks old. We spent eleven days in the hospital, three of those days were spent in the PICU."
Preemie	The extreme precarious medical status of an infant born weeks before their due date	Reassurance Satisfying Reaction	"Got the owlet because I had my son at 32 weeks & was so nervous when we brought him home." "Bought to monitor saturation risk for premature birth baby returning home."
Transitioning	Transition the infant out of the parent's room or into their own crib	Reassurance Freedom Reaction	"We started using it when we moved little one to his own room at 3 weeks old." "This is perfect for that transition to the crib, especially when they are going in way younger than you anticipated."

oxygen saturation. For example, one reviewer described the fragile medical condition of their daughter in detail, articulating how it motivated them to purchase the IMS:

> We decided to buy this monitor after my daughter's second heart surgery. We were still in the hospital when she coded and we had this huge fear that this would happen when we were at home sleeping. The reason she is with us today is because she was hooked up to monitors with a nurse right there. Besides her heart condition, she also has a hypoplastic left lung and bronchial malacia. She is currently on low flow oxygen to keep her sats up.

In addition to the acute or chronic conditions described previously, some parents experienced a medical scare that helped them decide to purchase or use the IMS. Some of these scares are choking episodes where they wake up to the infant choking on their saliva or vomit. Some of them are SIDS scares where they check on the infant and find them not breathing. One mother described the experience in detail,

> I purchased this after my daughter had an ALT-E (apparent life threatening event) at 3 weeks old. She stopped breathing spontaneously and my husband had to perform CPR to resuscitate her. I just happened to be watching her in the crib at that time and noticed she wasn't breathing. After coming home from the hospital I knew I would need something so I could "watch" my baby and attempt to sleep."

All of these pre-existing conditions, whether it be a diagnosed condition that necessitated a hospital stay, choking in their sleep, or SIDS scare, motivated the caregivers to purchase the IMS to monitor their child's heart rate and oxygen saturation.

Similar to the pre-existing conditions, the second physical driver is if the infant is born premature, usually before the start of the 37th week of pregnancy. The fragile nature of a premature infant's health status drives the parent's desire to purchase and use the IMS. Similar to infants who spend time in the NICU, preemies can receive specialized care. Parents who then take their infant home feel inadequate to care for the infant themselves. Some parents of preemies want the IMS even though they know their infant has no health problems, like this parent expressed, "My daughter was born 6 weeks early and thankfully didn't have any health problems but when i saw the owlet i knew i needed it." Other premature infants have a host of medical issues because they are were born before fulling developing their lungs. Another parent described their experience with their premature child this way,

> We had a little boy 9 weeks early and if you've had a preemie you know about "bradycardias" and "apneas" where heart rate slows and and breathing can stop, and you have to stimulate him to get him going again. Very stressful. After 5 weeks of that in the NICU, he was much improved but we came home and were not given a monitor even though he had a brady the day before we left. He self-recovered after 30 seconds so dr said he won't need a monitor. Needless to say we were still nervous.

The previous example demonstrates the interconnectedness of pre-existing conditions and premature infants. Despite the similarities, premature babies were kept as a separate driver due to their unique ability to motivate IMS use above and beyond any pre-existing conditions.

A transitioning infant is the final physical driver. Most infants sleep in the same room as their parents. Eventually, the infant transitions out of the parent's room into their own crib, room, or other sleeping arrangements. This transition increases the physical distance between the caregiver and infant. One parent explained their thought process this way,

> We recently transitioned my newborn from the bassinet next to our bed to the crib in her room. I felt comfortable when she was in the bassinet because I would hear her breathing, but having her in her room made where I couldn't check on her as often me a nervous wreck. We have a video monitor, but it wasn't enough. My husband and I decided to order the Owlet, and it made the transition to much easier!

The transition of an infant out of the parent's room is a physical driver of the IMS use that, similar to the other physical drivers, highlights the other emotion and behavioral drivers. The transition can increase the fear and anxiety over something happening to the infant while sleeping. Alternatively, in concert with a behavioral driver like caregiver sleep issues, it can motivate the purchase or use of the IMS.

While the emotional, behavioral, and physical drivers are distinct, each parent's circumstances weave the different drivers together in such a way to motivate the use of the IMS. The following online review demonstrates how the different drivers work together to steer parents towards using the IMS,

> After losing our fist child, we were already anxious when our second daughter came along. Our fears only increased when she decided to become a tummy sleeper. (We tried everything to avoid this) Our daughter was sleeping though the

> night, but we weren't! We were getting up to check on her multiple times throughout the night! We realized how silly it was for us to be up all night when our 3 month old never got up!

In this example, the infant only sleeping on her stomach has increased fear and anxiety from a prior loss. This situation leads to the parents continually checking on the infant and not getting enough sleep. The emotional driver of fear weaves with the behavioral driver of the infant sleep issues that leads to the ultimate behavioral driver of caregiver sleep issues. All of these drivers working together motivate the use of the IMS. In addition to this example, there are many possible combinations of emotional, behavioral, or physical drivers that can lead to IMS use.

Outcomes of Infant Monitoring

In keeping with the conceptual separation of use, affordances, and outcomes, the following section details the outcomes associated with the use of the IMS. The identified outcomes are separated by positive and negative outcomes based on their impact on both the caregiver and infant. They are also divided by emotional, behavioral, and physical outcomes.

Positive Emotional Outcomes

The positive emotional outcomes revolve primarily around the actualization of the affordances. The positive emotional outcomes identified are anxiety relief, comfort, gratefulness, and contentment. Table 5.10 defines and provides examples for each of these outcomes. The most effortless emotional outcome to explain is anxiety relief. It is derived directly from the anxiety driver through the reassurance affordance. As one parent succinctly states, "This product offers a sense of calm to the terrifying situation of

Table 5.10. Positive Emotional Outcomes

Outcome	Stimulus	Primary Affordance or Constraint	Example from Data
Anxiety Relief	Green light on base station and knowledge that IMS is "watching" baby for you	Reassurance Satisfying Freedom	"Nothing beats that green glow of peace of mind!" "The Owlet is an extra set of "eyes" to keep on your baby."
Comfort	Seeing real-time vital signs on mobile app	Satisfying	"What I cannot see visually, I can pull up the app and review my baby's readings. The comfort is indescribable."
Gratefulness	Device identified condition via true alarm	Reaction	"We are grateful for having the owlet in our lives especially since the 1st month she had a fever over night and we did not know… Thank you to the owlet for alerting us."
Contentment	False alarms indicate the system is working	Reassurance	"I know some people complain about false alarms but I would rather have a false alarm everyday instead of what could happen"

caring for a newborn." This emotional outcome is stimulated from either the green light on the base station or the knowledge that the IMS is monitoring the infant. Comfort, the second positive emotional outcome, arises from seeing the infant's real-time heart rate and oxygen saturation on the mobile application. A healthcare professional expressed the comfort of knowing the vitals this way,

> As a health care professional, the idea that I could monitor her heart rate and O2 sats at home was extremely comforting, allowing me to get the rest I needed to heal and be at my best to care for my baby.

Gratefulness is a positive emotional outcome that comes from genuine positive alarms via the IMS. One example is the gratitude a parent expressed in an online review following the IMS alerting,

> We are so thankful we were using our Owlet with our 2 week old boy. Just last night we kept getting alerts about our baby's heart rate, and we knew something

> was up. We headed to the ER promptly after getting enough consistent alerts. Come to find out, our baby was in SVT, and the Owlet saved his life.

Finally, contentment is an emotion expressed by the parents when justifying the many alarms that are not true positive alarms, specifically yellow and blue alarms. A parent described the contentment in this manner,

> With the owlet I don't have to worry [if I fall asleep] because I know it will alert me if there is something wrong. Even though it might alert me and it be a false alarm, I am ok with that!"

The parents experiencing contentment due to the false alarms believe these alarms are worth it to detect one true positive.

Positive Behavioral Outcomes

The largest number of outcomes is within the positive behavioral category. The positive behavioral outcomes are positive from the reviewer's perspective of the outcome being convenient or beneficial.

Table 5.11 lists and defines each of the six positive behavioral outcomes. The most common behavioral outcome is improved sleep. Knowing the IMS is watching the child allows the parents to sleep more comfortably when the infant is sleeping. The improvement in sleep is not a novel finding as the manufacturer of the IMS had previously commissioned research that found 94% of users reported betters sleep (Dangerfield et al. 2017). Arising from the satisfying and freedom affordances is the virtual checking on the infant outcome. This behavior of checking the infant's status from a virtually unlimited distance allows parents who are away at work to know the infant's status. A great example of this from the data is a night nurse who commented that she is now able to use her phone to check on her baby while she is at work. This outcome also

Table 5.11. Positive Behavioral Outcomes

Outcome	Definition	Primary Affordance or Constraint	Representative Example from Data
Improves Sleep	Sleep deeper and longer	Reassurance Satisfying	"We've had ours for 9 months now and love it. I can actually sleep knowing that our little guy is being monitored." "When I watched a video on (SIDS) I lost sleep (to be specific, all of the sleep) I would stare at my baby for hours, because she wasn't sleeping on her back and was rolling on her side. This sock let me get much needed sleep!"
Virtual Checking on Infant	Checking and knowing infant's status from unlimited distance	Satisfying Freedom	"I work nights at time so I always feel better being able to check on my baby girl from my phone." "It allowed me the freedom to sleep, shower, and do things around the house instead of hovering over our little one just to make sure they're breathing."
React When Needed	Intervene when needed	Reaction	"We've only had one red alert, and it happened when we needed it! Our baby was laying facedown on his nose!" "But we did get an alert in the first week in the middle or the night and it turned out she had spit up and was choking."
Transition Infant	Ability to move infant into own room/crib	Reassurance Freedom Reaction	"We switched our little guy to his crib for all naps, which puts his on the upstairs level when he's asleep and the rest of us are on the floor below."
Observe Sleep Patterns	Use vitals to track infants sleep cycles	Satisfying	"We like looking at the heart rate and know when he's in a deep sleep." "So it's nice to see how changing something with their nightly sleeep routine (no longer swaddling, adding/taking away white noise, etc.) affects their sleep."
Travel with It	Use with and without WiFi away from the home	Freedom	"I've used this device in the car on a long drive when I was alone with my baby and it worked perfectly plugged into USB power." "I use this every day and take it on vacation."

occurs with parents who are trying to accomplish other tasks, either around the house or a different location, other than paying constant attention to the infant's health. The behavioral outcome of reacting when needed is carefully separated from the reaction affordance. This reaction is the behavior that occurs when a true-positive alarm sounds. The reaction affordance is different in that it is enacted through the use of the technology, whether a red alarm sounds or not, and the react when needed outcome only occurs after a true, red alarm alerts the caregiver to react. The fourth positive behavioral outcome, transition infant, is similar to the behavioral driver, transitioning. One parent wrote this review to explain transitioning the infant, "We moved our little one into her own room after two weeks because I couldn't sleep with her in our room. The owlet is the only reason I was comfortable with the move!" While the transitioning driver motivates the use of the IMS, the outcome of actually transitioning also occurs in many user's whose initial goals were something other than transitioning the infant. Observing the infant's sleep patterns is the fifth positive behavioral outcome. This outcome occurs when caregivers use the mobile app to track the infant's historical vital signs while sleeping. The mobile application can indicate deep and light sleep for the infant. Some parents were able to use the real-time heart rate displayed in the mobile application, in conjunction with the historical averages, to tell when the infant was in a deep sleep. This knowledge enabled some parents who had rocked their baby to sleep to know when the baby was in a deep enough sleep to put them in their crib without waking them up. The final positive behavioral outcome is that some parents travel with the IMS. Because the base station does not require internet connectivity to operate, only to set up initially, some parents use the IMS to monitor the infant on long road trips in the car. Others bring the

IMS with them when they travel, connect the base station to WiFi at their final destination, and use the IMS to monitor their infant while on vacation.

Positive Physical Outcomes

Two positive physical outcomes were revealed from the data, defined in Table 5.12. A physical outcome is a measurable, non-emotional, or non-behavioral outcome that can be directly tied to an affordance or constraint. Thus, an identified medical need and the IS working as expected when compared to a certified medical device are the two positive physical outcomes. The first physical outcome of a medical need identified is related to the reaction affordance and react when needed behavioral outcome. Due to reacting to a red alarm, a medical need is identified through a medical diagnosis. Without the device, the medical diagnosis would not have been identified. This outcome is more

Table 5.12. Positive Physical Outcomes

Outcome	Definition	Primary Affordance or Constraint	Representative Example from Data
Medical Need Identified	Used device to identify need for medical intervention	Reaction	"We started getting red alerts for high heart rates. At first, we thought that it might be false alarms, but it we were only getting alerted for high heart rates and nothing else. That made me believe something else was going on. After about a week of this, I had enough and told his pediatrician about it. She immediately sent us to cardiology. Long story short, my son was diagnosed with SVT and the Owlet lined up with the holter monitor he had to wear for 48 hours.If it wasn't for the Owlet, we never would have known about this"
Works as Expected	Device works similar to or better than a medical device	Reassurance	"We used the hotspot on out phones to set this up in the hospital to test the accuracy. The heartrate is always within 1 bmp as the hospitals machine and the oxygen is exact." "my husband and i have been nurses for 5years and we equate this device to the hospital devices"

than merely reacting to a red alarm. It is that the red alarm helped identify an underlying medical issue. The other positive physical outcome is the finding that the IMS is as accurate or more accurate than a similar medical device. An online reviewer compared the IMS to a hospital monitor, "This product works better than the pulse ox machines in the hospital. It is quicker and more accurate." It is important to note that this outcome is from the perspective of the caregiver, not a scientifically proven fact. Research in the literature is mixed on the accuracy of home-based pulse oximeters (Bonafide et al. 2018). The belief that the device works similar or better than a medical device comes from either the user's experience or a comparison with a medical-grade heart rate monitor or pulse oximeter in the hospital.

Negative Emotional Outcomes

The negative emotional outcomes exist in contradiction to the emotional drivers of the use of the IMS. Although many caregivers use the IMS to help alleviate negative emotions, see the reassurance and satisfying affordances, continued negative emotions, or even additional negative emotions can be an outcome. Table 5.13 provides the three negative emotional outcomes. The emotions are negative in the sense that they are on the negative end of the valence scale and vary in their arousal levels. The first negative emotional outcome is an increase in anxiety. Stimulating increased anxiety is all of the alarms that are not true-positive red alarms. The yellow placement, blue connectivity, and false red alarms can lead to increased anxiety in the parent. Additionally, the conditioning to the data stream can lead to increased anxiety by the parent always wanting to know the infant's current vital signs. A caregiver described the increase in anxiety in this manner, "It works exactly as it says, for me personally it just gave me more anxiety then comfort.

Table 5.13. Negative Emotional Outcomes

Outcome	Stimulus	Primary Affordance or Constraint	Example from Data
Increased Anxiety	False Red Alarms Yellow Alarms Continuous Stream of Data	Uncertainty Conditioning Reliability Design	"So, when you have a screaming baby, a base station that's screaming high pitched lullabies, and your phone dinging over and over, its bound to make any mom go crazy" "There were a few scary "sock placement alarms" when we first used it before we really understood the different tones and color warnings."
Annoyance/ Frustration	Continuous Yellow & Blue Alarms False Red Alarms Unreliable Mobile App	Learning Curve Reliability	"I was very disappointed in the Owlet. I (thought I had) upgraded from the Snuza Hero to the Owlet, however, quickly realized that for the three weeks I had the Owlet I would get a false notification every. single. night." "We have also had false RED alarms. It told me her oxygen was down to 77%! I was holding her and this was NOT the case." "The app is horrible, it glitches constantly, the alerts are 30 min later and it sends it 36 TIMES and freaks out your phone"
Ethical Questions	Privacy of Data Preys on Anxious Parents	Design	"I also find it very peculiar that the company collects the data but does not even share it with the consumers. Only reason why I mention this is because all too often there are 'server' issues displayed." "This one got me thinking....we got a red alert our first night and the next morning I received a text from the company asking if I had any questions about the alert and if I would like to speak to anyone on ways to prevent it, etc." "Owlet is a company whose business mode is centered around the fears and anxiety's of parents, lots of them first time, many like me who had a baby that stayed in the NICU. They have taken advantage of this and taken it too far, in my opinion."

I found myself constantly checking the app to see the heart rate and oxygen of my baby." An increase in the level of anxiety indicates a movement in the level of arousal of the emotion.

The second negative emotional outcome evident in the data is annoyance or frustration. The main difference between the emotional response being classified as annoyance or frustration is the level of arousal indicated in the review. The source of much of the frustration is the difficulty keeping the sensor placed correctly on the infant's foot and connectivity issues, yellow and blue alarms. However, constant false red alarms for some individuals and bugs in the mobile application causing a delay in notifications amongst other issues led to annoyance and frustration.

To illustrate the first two negative emotional outcomes, I present the following extended review that paints a vivid picture of the anxiety and frustration that can result from using the IMS.

> WHY WON'T THE STUPID "HUSH LITTLE BABY" TUNE SHUT UP FOR HALF A SECOND SO I CAN FIX THE PROBLEM?!Picture this: It's 3:30 am and I've been sitting up in bed all night. All. Night. I nod off while nursing my son for probably the hundredth time tonight. My neck and back are ON FIRE. I am finally coherent enough to try to put my son down. Miracle beyond miracles: I get him in his crib and he stays asleep. I need to pee, but darn it, I don't want to wake him up, so I hold it and go back to bed. Desperate times have arrived, my friend. I melt back into bed, slowly, to try to avoid making any noise so my sleeping son will continue to sleep. Finally, my head hits the pillow and there's sweet, sweet relief to my strained muscles. I begin to relax. Maybe he will sleep longer than 45 minutes this time. Then, out of the pitch black, sweet silence of night, my OWLET MONITOR starts it's digital rendition of "Hush Little Baby", blaring both music and glowing, dancing light into my refuge of slumber. The baby stirs, I jump out of bed, press the base station to turn off the cacophony, but alas, it immediately begins again as soon as my hand leaves the singing, flashing disc. I smash my hand back down again. Again the singing continues. At this point the baby truly beginning to awaken. I, in a postpartum, sleep deprived rage that only mothers of 2 under 2 will understand, am now seriously considering violence against this inanimate object that I usually rely upon to ensure more relaxed sleep. I have visions of watching it explode at the end of a gun range,

> maybe running it over with my car, throwing it over a cliff. Please God, make the singing stops. Finally, I abort the mission and run over to my baby and wrestle the tangled, Velcro strap off of his ankle and shove the cord back into its charging port. I'd like to say there was peace after that, but my baby was now screaming. There's no telling what he thought was happening, and it will surely take another 2 hours to get him back to sleep. I hear my 1.5 year old stir in the next room. Me and my son climb back into bed and begin a new 2-hour-long nursing/pacifying sessions (these first teeth aren't pleasant). My husband's phone vibrates, it's time for him to wake up. My chance for sleep has likely passed for the next hour until he's gone off to work. If the sleep anxiety isn't keeping me awake, of course, it'll be the overpriced singing sock who refuses to be snoozed or turned off.

This review uses colorful imagery to illustrate the negative emotional outcomes of anxiety and frustration that can arise from yellow or blue alarms.

The third negative emotional outcome is descriptively named ethical questions instead of being titled after the specific emotions experienced. I use the title ethical questions as it better captures the essence of the emotions stimulated by the questionable use of the data collected by the IMS and the perception that the company takes advantage of the emotions felt by new parents. Anecdotes from the data show customer service representatives contacting caregivers following a red alarm to make sure everything is going all right, raising questions about the third-party use of the IMS data. Also, several reviewers were skeptical of the reasons why the base station had to be connected to the internet during the initial setup with the setup process, including asking several personal questions about the infant and parent. A reviewer raised the following rhetorical questions on the privacy practices of the IMS,

> I cannot recommend this product until the company addresses the significant privacy concerns implicated by the app required to setup this device. Why does the app require a parent to submit her name and date of birth to setup the app? How is that information used and why is it required? How does that information help the app monitor a baby? Perhaps the company could provide an explanation?

Finally, several reviewers were concerned about the marketing practices used to target parents of loss or those experiencing high anxiety. An indignant reviewer commented, "Its wrong that these companies are banking off parents insecurities and anxieties."

Negative Behavioral Outcomes

Similar to the number of positive behavioral outcomes, there are many different negative behavioral outcomes. Table 5.14 defines and provides examples for each of the negative behavioral outcomes. The first is diminished sleep. This outcome occurs when the caregiver or infant experiences even worse sleep than before using the device. The increased lack of sleep is usually caused by constant alarms from the base station, whether yellow or blue alarms. However, some of those who experienced worse sleep attributed it to needing to constantly check the vital signs of the infant on the mobile application throughout the night. This reason for diminished sleep leads to the second negative behavioral outcome of data conditioning. Data conditioning is defined by the constant checking of the data or the inability to imagine not using the device. Reviewer after reviewer commented on or alluded to the conditioning to the data that can occur, like this parent, "it can also make you crazy if you Keep watching the numbers. My suggestion-- put it on, make sure it's reading, and then close the phone." The third negative behavioral outcome is the unsafe sleep practices justified through the IMS use. Whether it is co-sleeping in the same bed as the infant, putting the infant to sleep on their stomach, or other sleep practices that go against AAP recommendations (Task Force on Sudden Infant Death Syndrome 2016), caregivers feel comfortable following unsafe sleep

Table 5.14. Negative Behavioral Outcomes

Outcome	Definition	Primary Affordance or Constraint	Representative Example from Data
Diminished Sleep	Caretakers or infant sleeps worse than before using the device	Learning Curve Reliability Design	"I lost more sleep with this product than without it" "We're already sleep-deprived. We don't need false alarms waking us up even more."
Data Conditioned	Constant checking of data or inability to imagine not using	Satisfying Conditioning	"The peace of mind has been great, although I STILL find myself checking on her throughout the night whether it be by pulling up the app on my phone and looking at her stats or by physically feeling that she is breathing" "Do yourself a favor and don't become reliant on the owlet because it will just drive yourself crazy."
Unsafe Sleep Practices	Follow unsafe sleep practices with infant	Reassurance Freedom Reaction	"We found our baby sleeps much better on his stomach or with a pillow. I will say the Owlett company makes it very clear not to go against the "on the back, nothing in the crib" style of sleep for obvious reasons. But our baby would not sleep on his back so we had to resort to other things. With that said he is 3 months now and often sleeps on his stomach, side or on his back with a pillow and I would not have been willing to risk these other tactics and allow him comfort and sleep of it weren't for this product."
Forgetfulness	Forgetting to charge sock or put on to infant	Design	"I had one night where I forgot to charge it and I barely slept." "For some reason, because I never turned it off in the first place, sometimes I forget to turn it back on - so I'll wake up in the morning and realize I truly had a false sense of security all night, since I had forgotten to turn the base on and she hadn't been monitored at all."
Advised Against Continued Use	Recommended by a medical professional to discontinue use	Reliability	"We talked to our doctor and he said that these products aren't very accurate anyway and it is best if we got rid of it." "This product just did not work well for us. Too many inaccurate O2 readings. Our pediatrician recommended returning it."

practices due to the perception that the is IMS monitoring the infant for them. A caregiver explained the unsafe sleep practice outcome,

> What adds to the risk is that Baby is a stomach sleeper which is not recommended because baby's face could be smothered by the mattress and suffocate. With the owlet on, we can rest assured knowing that if there is any abnormal heart beat or oxygen level, the alarm will sound.

Forgetfulness is the fourth negative behavioral outcome. The forgetfulness is related to the IMS not being operational when the caregiver either wishes it is or thinks it is. This occurs when the user forgets to charge the sensor and the battery is dead when going to use it. It can also occur when the caregiver turns the device off in the middle of the night to prevent a false alarm during a feeding, for example, and forgets to turn it back on. The final negative behavioral outcome is when the caregiver's pediatrician recommends not to continue the use of the product. This negative recommendation is either due to perceived issues with the device's accuracy or the AAP's recommendation not to use cardiorespiratory monitors to help prevent SIDS (Task Force on Sudden Infant Death Syndrome 2016).

Negative Physical Outcomes

Two negative physical outcomes were evident in the data, Table 5.15. The first, named false alarms, is the outcome of either false positive alarms and false negative alarms. Many reviewers mention false alarms. However, the reviewers typically are referring to either yellow alarms or blue alarms when they mention false alarms. This physical outcome is the false-positive red alarms and the false-negative non-alarms. The false red alarms serve as a "boy who called wolf" type call that triggers the react when needed behavioral outcome only for the caregiver to realize the reaction was not necessary. A parent described a false-positive alarm for a high heart rate, “We have had one red alarm for a high heart rate but when I checked my babies pulse it was nowhere near the reading of 220 that the machine gave.” In addition to the false positives, a few

Table 5.15. Negative Physical Outcomes

Outcome	Definition	Primary Affordance or Constraint	Representative Example from Data
False Alarms	False positive alarms and false negative non-alarms	Reliability	“Three false red alarms. The first I almost had a heart attack. After that twice I’ve been sitting there watching him and all of a sudden the alarm goes off red. He is breathing normal and his pulse is fine. If I get false alarms how the heck am I supposed to have peace of mind that I don’t have a false green light?” “We had some other health issues with our baby that led us to get an apnea monitor prescribed from our doctor. The apnea monitor that the hospital gave us would go off like crazy. I put the owlet and the hospital apnea monitor on her together one night. Apnea monitor would alarm, owlet would stay green. I was convinced that the apnea monitor might be malfunctioning because it would go off many many times an hour. We got a sleep study for our daughter and results came in as followed - SEVERE OBSTRUCTIVE SLEEP APNEA & SEVERE CENTRAL SLEEP APNEA. She stopped breathing for >20 seconds an average of 32 times AN HOUR. Her oxygen was at 82 most of the night. Why did the owlet not EVER detect ANYTHING? No notifications for an entire 4 months of use. If it can’t even detect severe apnea, what does this thing even do?”
Injured Infant’s Foot	The sensor burns or cuts the infant’s foot	Learning Curve Design	“The sock sensor light left a burn mark on my baby’s left foot.” “I noticed it cut one foot so I switched it to the other foot thinking that I probably put it on too tight. On the other foot I put it on too loose and after a minute I noticed it was even falling off so I took it off to try to put it on better. That’s when I noticed she was cut from it on that foot from wearing it for less than a minute, and THERE WAS EVEN BLOOD ON THE SOCK!!!”

instances of a false negative non-alarms are evident in the data, despite the difficulty in detection. These false negatives happen when there is either a change in heart rate of drop on oxygen saturation that the IMS should have noticed, but does not. Both of these types of alarms degrade the trust in the IMS to truly monitor the infant. Injury to the infant's foot is the second negative physical outcome. The injuries noted are either a burn or laceration on the infant's foot, where the sensor is placed. These uncommon injuries are explained either by improper placement of the sock or poor quality of the sock.

Feedback Loops

The dashed lines in Figure 5.2 represent feedback to either IMS use or the features included in the IMS. The first dashed line represents the actualized affordances motivating the continued use of the IMS. Those parents who report actualizing the desired affordance often state a desire or intention to continue using the IMS. Many users are effusive in their praise for the IMS, for example, "The most important thing I own for my baby, hands down. I will not put him to sleep without it. It is worth every dollar to know that my little one is breathing while I'm sleeping." Some caregivers love the IMS so much they want to use it as long as possible, even when their child is much older. For example, one reviewer who described herself as a "customer for life" claims to use the device on her now much older children because of the reassurance affordance, "My kids are 2 & 4 now, but when they are sick, I still put the Owlet on them for sleeping to ease my anxious heart & mind." Thus, as shown in the Affordance-Constraint-Outcome Model in Figure 5.2, the affordances motivate the continued use of the IMS.

While the constraints are in tension with the affordances, they can lead to the future development of additional features. The perfect example of this is tied to the emotional constraint of uncertainty and the physical constraint of design. When the IMS was first released, there were two mobile applications, one to view the real-time vital signs of the infant and one to view the historical data. The mobile application designed to view the historical data and trends of the infant was called the Connected Care App. The two separate apps lead to some uncertainty as the caregivers were unsure as to the purpose of the separate apps. In addition, some caregivers were upset that to access the Connected Care App's historical trends, they had to pay a fee. This additional cost led to many ethical questions as parents viewed it as having to pay to access their own data. Eventually, the constraints of uncertainty and design led the designers to choose to offer the Connected Care App for free. However, this still led to some uncertainty as parents did not understand the reasons for two separate mobile applications. Finally, only recently and several years after the initial release of the IMS, the designers merged the two mobile applications into one. Thus, the emotional and behavioral constraints led to the refinement and development of additional features.

The following section maps the drivers of IMS use to the desired affordance and the outcomes to their affordance or constraint and develops the theoretical relationships between them.

CHAPTER SIX

Discussion

This section discusses the findings related to the theoretical relationships between the constructs previously identified and visually depicted in the Affordance-Constraint-Outcome Model (Figure 5.2). The first set of findings explain the relationship between the emotional, behavioral, and physical drivers and the affordances of the use of the IMS. The second set of findings explain the tension between the desired affordances, the constraints, and their respective outcomes.

Relationships between Drivers and Affordances

The drivers evident in the data do not exist in a vacuum. Each of the different drivers is entangled with the others. For example, with the caregiver sleep issues behavioral driver, the parents have trouble sleeping because of fear that something might happen to the infant while they sleep. Alternatively, because the infant has a medical condition that necessitated an extended stay in the NICU (pre-existing condition) with constant monitoring (prior data conditioning), the caregiver has extreme fear and anxiety over what could happen to the infant. However, the caregivers in the data can be split into two categories, those with a medical need for the IMS and those without. When a medical need is evident, it spurs the physical drivers which, in turn, stimulate the emotional and behavioral drivers. When a medical need for monitoring is not readily apparent in the infant, the emotional drivers motivate the use of the IMS. I, therefore, present the first major finding, Major Finding 1A: The physical drivers motivate the IMS use the most for those with a medical need.

Major Finding 1B: The emotional drivers motivate the IMS use the most for those without a medical need.

To show the relationships between the drivers IMS use and the affordances provided by the IMS, I mapped them together, following the example of Karahanna et al. (2018). The following section discusses the mapping between the affordances and drivers shown in Figure 6.1. In mapping the specific drivers to each of the affordances provided by the IMS, Figure 6.1, several themes in the relationships are apparent. Between the emotional drivers of fear, anxiety, and mom guilt, all of the emotional and behavioral affordances are covered. Between the physical drivers of pre-existing conditions, preemie, and transition, all emotional and behavioral affordances are also covered. However, the behavioral drivers, by themselves, only motivate the emotional affordances.

Fear and anxiety, as the emotional drivers, are mapped to the reassurance, satisfying, and reaction affordances. The parents crippled by these emotions are looking

	Emotional Drivers			Behavioral Drivers			Physical Drivers		
Affordances	Fear	Anxiety	Mom Guilt	Caregiver Sleep Issues	Infant Sleep Issues	Prior Data Conditioning	Pre-existing Condition	Preemie	Transitioning
Reassurance	✓	✓	✓	✓	✓		✓	✓	✓
Satisfying	✓	✓		✓		✓	✓	✓	
Freedom			✓						✓
Reaction	✓		✓				✓	✓	✓

Figure 6.1. Mapping of Drivers to IMS Affordances

for reassurance that their infant is healthy, need their fears and anxieties relieved by knowing the infant's real-time vital signs, or need the ability to react if their worst fears become realized. Those caregivers motivated by mom guilt need to feel like or be able to demonstrate to their peers that they are doing all they can to be reassured their infant is healthy while sleeping and will be alerted if something is wrong. They also desire the freedom to multitask and not be tied down to continuously monitoring the infant's health. Thus, mom guilt is alleviated through the actualization of the reassurance, reaction, and freedom affordances.

For the physical affordances, there is a similar trend when compared to the emotional affordances. The drivers of a pre-existing condition and the infant's premature birth are related to the reassurance, satisfying, and reaction affordances. Parents of infants with a medical condition or born prematurely want to know if the infant's heart rate and oxygen saturation are within limits, want to know precisely what the numbers are, and want to be alerted if the numbers go outside of limits. Parents of transitioning infants want the reassurance and reaction, but also desire the freedom the IMS provides. In summary, both the emotional and physical drivers motivate the use to achieve all types, emotional and behavioral, of affordances. This leads me to the following finding,

> Major Finding 2: Emotional and physical drivers motivate both emotional and behavioral affordances.

From the data, the behavioral drivers motivate differently than the emotional and physical drivers. While there is more variation in the type of behavioral driver, they are primarily related to the reassurance and satisfying affordances. Parents who have trouble sleeping want to know that their baby is okay or what the infant's current vital signs. For infants struggling with sleep issues, the parents just want the reassurance that the infant is healthy. Finally, parents who have already been conditioned to the stream of data from remote health monitors desire to continue the stream of data with the IMS via the satisfying affordance. As suggested previously, these behavioral drivers usually occur in tandem with either the behavioral or emotional drivers. A parent's struggle to sleep is often caused by increased fear or anxiety. The infant's sleep issues could be caused by transitioning. Despite these entanglements, when viewed separately, the behavioral drivers only map to the emotional affordances, not the behavioral affordances. Therefore, I present,

Major Finding 3: Behavioral drivers only motivate emotional affordances.

Relationships between Affordances, Constraints, and Outcomes

In mapping the affordances, constraints, and outcomes, I followed the same process as mapping the drivers and affordances. Figure 6.2 shows the results of mapping each affordance or constraint to their respective outcomes. Each of the outcomes was mapped to a specific affordance or constraint. Multiple outcomes can arise from multiple affordances or constraints. Based on these relationships, I present additional major findings.

		Positive Outcomes												Negative Outcomes									
		Emotional				Behavioral						Physical		Emotional			Behavioral					Physical	
		Anxiety Relief	Comfort	Gratefulness	Contentment	Improves Sleep	Virtual Checking	React when Needed	Transition Infant	Observe Sleep Patterns	Travel with It	Medical Need Identified	Works as Expected	Increased Anxiety	Annoyance/ Frustration	Ethical Questions	Diminished Sleep	Data Conditioning	Unsafe Sleep	Forgetfulness	Advised Against Use	False Alarms	Injured
Affordances																							
Emotional	Reassurance	✔	✔		✔	✔			✔		✔		✔						✔				
	Satisfying	✔	✔			✔	✔			✔		✔		✔				✔					
Behavioral	Freedom	✔					✔		✔		✔								✔				
	Reaction			✔				✔	✔			✔	✔				✔		✔				
Constraints																							
Emotional	Uncertainty													✔									
Behavioral	Learning Curve				✔										✔		✔						✔
	Conditioning													✔				✔					
Physical	Reliability													✔	✔		✔				✔	✔	
	Design				✔									✔	✔	✔	✔			✔			✔

Figure 6.2. Mapping of Affordances and Constraints to Outcomes

Affordances exist in the relationship between the goals of the user and the features of the technology. As such, users with positive goals interact with the features of a technology in such a way to take advantage of positive affordances. That is not to say there are not nefarious actors that use technology in negative ways. However, a primary assumption in this research is that parents want the best for their children and themselves and will use the features of the technology to do what they believe is best. Nevertheless, affordances can produce negative outcomes. These negative outcomes, generated by the affordance, can be viewed as the second or third-order effects of the parents' positive goals. The best example of this is the negative behavioral outcome of unsafe sleep practices. Due to the reassurance, freedom, and reaction constraints, parents feel more comfortable not following the AAP safe sleep guidelines, resulting in a negative outcome. The satisfying affordance can result in the caregiver being conditioned to the instant access to knowing the infant's vital signs. The reaction affordance can result in worse sleep as the caregiver is awake all night, reacting to alarms, false or otherwise.

Constraints are a function of the technology's features that constrain or limit the affordances of the IS. Observing the constraints and outcomes, the only positive outcome that arises from a constraint is contentment. The contentment is due to the parent's belief that the constraints of a learning curve or the technology's design are worth it for the benefit of the technology. They are content with the constraints due to the perceived benefits of the technology. Therefore, I present for the following finding,

> Major Finding 4: Constraints rarely produce positive outcomes, while affordance produces some negative outcomes.

Examining the emotional affordances, it is apparent that they produce a wide array of outcomes. Both the reassurance and satisfying affordances have emotional, behavioral, and physical outcomes. It is tautological that an emotional affordance has emotional outcomes. Both the reassurance and satisfying affordances produce the emotional outcomes of anxiety relief and comfort. The emotional affordances also produce positive behavioral outcomes. They both help improve sleep, amongst other positive behavioral outcomes. Also, reassurance creates the positive physical outcome of perceiving the IMS works as expected. The satisfying affordance produces the physical outcome of helping identify a medical condition when a change in heart rate or oxygen saturation is observed in the mobile application.

Not all of the outcomes of the emotional affordances are positive, however. Both reassurance and satisfying have been shown to create negative outcomes. As previously discussed, reassurance can produce the negative behavioral outcome of unsafe sleep practices by reassuring the parent that the infant is healthy while going against the AAP recommendations. Satisfying can produce the negative emotional outcome of increased anxiety in conjunction with the negative behavioral outcome of data conditioning. Thus, I pose the following,

> Major Finding 5: Emotional affordances produce positive emotional, behavioral, and physical outcomes and some negative emotional and behavioral outcomes.

Behavioral affordances follow a similar pattern to the emotional affordances. An assortment of positive emotional, behavioral, and physical outcomes arises from the behavioral affordances of freedom and reaction. Freedom can result in the positive emotional outcome of anxiety relief and the positive behavioral outcomes of virtual checking and transitioning infant. The behavioral affordance of reaction can trigger the positive emotional outcome of gratefulness, the positive behavioral outcomes of react when needed and transitioning the infant, and the positive physical outcomes of identifying a medical need and transitioning the infant. Also, behavioral affordances can generate negative behavioral outcomes. Freedom and reaction can both lead to unsafe sleep practices. Reaction can also lead to diminished sleep. In summary, the behavioral affordances can lead to all the categories of positive outcomes and can also lead to negative behavioral outcomes. Therefore, I present the following finding,

> Major Finding 6: Behavioral affordances produce positive emotional, behavioral, and physical outcomes and some negative behavioral outcomes.

The sole emotional constraint of uncertainty, while broad in its definition, only leads to a small segment of the possible outcomes. Increased anxiety, a negative emotional outcome, is the only outcome that is evident from the uncertainty constraint. Because the emotional constraints only produce negative emotional outcomes and no behavioral or physical outcomes, I pose the following,

> Major Finding 7: Emotional constraints manifest as negative emotional outcomes.

The behavioral constraints of learning curve and conditioning to the data lead to a wide gamut of negative outcomes. Learning curve can lead to annoyance or even frustration as users figure out the best ways to use and interact with the IMS. This behavioral constraint can also lead to diminished sleep as the user fiddles with understanding how to operate the IS instead of sleeping. Finally, the learning curve can lead to hurting the child if, as claimed in the data, the improperly placed sensor harms the child’s foot. Conditioning to the data leads to the negative behavioral outcome of data conditioning. However, it can also lead to increased anxiety as the conditioned parent can feel more anxious when the data stream is not readily available to them. Therefore, I present the following, Major Finding 8: Behavioral constraints produce negative emotional, behavioral, and physical outcomes.

Because reliability and design, the physical constraints, are defined by the IMS not meeting the user's expectations, their outcomes are various. First, the reliability constraint is defined by the IMS not working correctly. Examples of poor reliability are when the battery does not hold a charge as long as expecting or even fails to charge at all, when there is a delay in the notifications via the mobile application, or when the IMS reports inaccurate vital signs, amongst the many other possible examples of reliability issues. The reliability constraint, therefore, can lead to a wide variety of possible combinations of negative outcomes. In terms of emotional outcomes, poor reliability can lead to increased anxiety or frustration when the device is not working correctly. The possible behavioral outcomes of reliability are diminishing a parent's sleep who is dealing with reliability issues or an infant's pediatrician recommendation to not continue use due to inaccurate readings. The physical outcome of reliability is false positive or false negative alarms. These false alarms, in turn, can breed more anxiety or frustration in the caregiver.

The second physical constraint of design is related to the IMS's physical limitations due to its design characteristics. One example of this is the Bluetooth connection between the sensor and the base station. Because of the inherent limitations of Bluetooth, the base station must be relatively close to the sock, usually in the same room. Because of this proximity, any alarm has a high likelihood of waking the infant. If the alarm is due to a reliability or learning curve issue, the possible outcomes are diminished sleep for both the parent and the infant and increased frustration. Another example of the design constraint is the inability to customize the alarms levels for the device. Parents who notice the preset alarms levels are nervous when they discover the device is not designed to alarm until the infant's oxygen levels reach 80%, much lower than what is generally considered safe. It can be frustrating when they realize the heartrate alarm levels are set to accommodate a newborn to an 18-month old toddler, 60-220 beats-per-minute, a wide variation that will only catch the most extreme changes in an infant's heart rate. Therefore, while the most common outcomes of the design constraint are negative emotional outcomes, behavioral and physical outcomes are also possible. I thus pose,

> Major Finding 9: Physical constraints produce negative emotional, behavioral, and physical outcomes.

Contributions

This research contributes to the personal data digitalization stream of research in several specific ways. This section outlines the contributions to theory and practice. The many contributions to theory in this research include a contribution to the remote health monitoring literature, the emotions literature, affordance theory, and the NAF perspective.

First, this study examines a continuous, biologic remote health monitoring system concerning the remote health monitoring literature. The remote health monitoring literature primarily focuses on the physical outcomes of using the technology like reduced cost (e.g., Cherry et al. 2002; Zanaboni et al. 2013), efficiency of operations (Singh et al. 2011), or implementation strategies (e.g., Dadgar and Joshi 2018). While examining the medical outcomes of remote health monitoring is essential from a clinical perspective (e.g., Varma et al. 2010), the remote health monitoring literature tends to ignore the emotional and behavioral outcomes despite repeated calls to further the understanding of health IT (Agarwal et al. 2010; Romanow et al. 2012). This research fills a gap in the literature by examining emotional and behavioral drivers and outcomes in addition to the physical aspects of remote monitoring that are better understood in the literature. It contributes to the remote health monitoring literature by expanding the motivators of the use of a remote monitoring system beyond the anticipated, positive, physical outcomes. Additionally, it identifies emotional and behavioral outcomes of the use of remote health monitoring the can more fully explain the impact of remote monitoring.

Second, this study contributes to the emotional literature by examining the anticipatory emotions and emotions in reaction to a non-IS stimulus. Previous emotions research in the IS discipline has focused on the role of an emotional reaction to an IS stimulus within the impact period of the stimulus (Beaudry and Pinsonneault 2010). An example of this type of emotional response is computer anxiety or playfulness when interacting with a personal computer (Venkatesh 2000). There is very little research exploring anticipatory emotions (Beaudry and Pinsonneault 2010). One example of a study examining anticipatory emotions in response to a non-IS stimulus examines the negative emotions in response to anticipated health outcomes (Anderson and Agarwal 2011). This research on the entanglement of emotions and affordances extends the emotions literature by explaining the role of emotions in response to a non-IS stimulus, driving the use of an IS. It shows how the coping behaviors associated with the emotions in anticipation and during the impact period of a non-IS stimulus can lead to the introduction of an IS stimulus. The emotional response to the new IS stimulus can either be helpful or be detrimental to the initial emotions in response to the non-IS stimulus due to the affordances and constraints of the IS.

The third contribution is to the affordance literature and further development of the NAF perspective. This contribution is in three parts. First, this research examines, at the individual level, outcomes incongruent with the desired affordance. Although Gibson (1977) acknowledges that not all affordances lead to positive outcomes, more recent affordance research either assumes positive outcomes from an affordance (e.g., Karahanna et al. 2018) or does not discuss the positivity or negativity of the outcomes of the affordance (e.g., Vaast et al. 2017). By including and labeling the negative outcomes, this research provides a more detailed view of the relationship between the drivers of use, the affordance, and the outcomes of the affordance. Mapping the positive and negative outcomes to their respective affordance or constraint in addition to mapping the drivers to their affordance provides a better understanding of the outcomes of the affordance.

Second, with respect to the affordance literature, this research furthers the NAF perspective by examining the entire process from the driver, through the affordance or constraint, to the outcome. The NAF perspective (Karahanna et al. 2018), which is straightforward in its design, only explains a single type of driver motivating the use and the affordances that satisfy that type of driver. It does not include any other outcomes in the model. Incorporating the entire process of driver, affordance, and outcome into the Affordance-Constraint-Outcome model, contributes to a nuanced view of the outcomes of an affordance, instead of assuming the affordance directly leads to the user's satisfaction. In addition, by including emotional, behavioral, and physical drivers, this research expands the boundaries of the NAF perspective beyond the sole driver of psychological needs.

The third specific contribution to the affordance literature is the examination of the tension between the perceived affordances and the constraints. Previous affordance research discusses constraints from the perspective that a user perceives an IS as either constraining or affording their goals (Leonardi 2011). Additional research discusses affordance failures (Benbunan-Fich 2019) but stops short of explaining more than not all perceived affordances are actualized. This study contributes to and furthers affordance theory by explaining that the tension between affordances and constraints can result in contradictory outcomes. These positive and negative outcomes can then muddle the true outcome of the affordance.

Finally, this study answers two specific calls from the literature for additional research. First, it identifies and develops a theoretical explanation for the use of an IS founded upon the identified emotional, behavioral, and physical drivers. By answering the call to examine the irrational antecedents to continued use (Ortiz de Guinea and Markus 2009), this research furthers the understanding of why individuals continue using specific information technologies. Additionally, it answers the Karahanna et al.'s (2018) call to identify the affordances and drivers of technologies from different contexts and categories than the social media context originally studied.

This research has several implications for practice. First, it identifies the reasons consumers purchase and use an infant monitoring system. Second, it explains the logic consumers use in deciding whether to continue the use of remote monitoring. These two implications are essential from an IS marketing and designer perspective in understanding the drivers that motivate a consumer's purchase. For the IS designer, understanding the role of constraints limiting the positive outcomes of perceived affordances is an important, third, implication for practitioners. This insight can contribute to the design decisions that maximize potential affordances while minimizing the emotional, behavioral, or physical constraints.

Limitations

Several factors limit the findings of this research. First, the findings might not be generalizable outside of the context of the study. Although I believe the IMS's entirely voluntary use in the emotionally charged environment strengthens the study, the findings might not apply in a remote monitoring context where the use of the IS is less voluntary or less emotionally charged. The use of eWOM and online reviews as a source of data when studying emotions and affordances is well-established in the IS discipline. However, the self-reported nature of online reviews lends itself to bias. Also, there is a selection bias in the individuals who self-select into writing a review. Varying the sources of data between the amazon reviews and the retail websites is meant to limit this bias's potential. In addition, compared to Facebook comments on the same topic, there was no difference between the three sources of data.

CHAPTER SEVEN

Conclusion

In this study, I investigated the relationships between the drivers, affordances, and outcomes of using an IMS. First, the data revealed emotional, behavioral, and physical drivers of IMS use. Whether rational or irrational, the emotional drivers, specifically fear and anxiety, are intertwined with the behavioral and physical drivers in motivating the use of the IMS. In motivating the use of the IMS, the goals of the user are revealed through the drivers.

Second, the data revealed the affordances and constraints of the IMS. Existing between the features of the IS and the goals of the user, emotional and behavioral affordances were identified. The users expressed a desire to continue using the system when they were able to actualize the IMS's perceived affordances. However, the constraints of the IMS create tension with the affordances. The constraints muddle the ability of the users to achieve their goals through the use of the IMS. When identified, the constraints can form a conduit for the IS designers to alter the current features or develop new features of the IS in order to minimize the constraints.

Third, flowing from the affordances and constraints, several positive and negative outcomes were identified. The emotional, behavioral, and physical outcomes of the affordances and constraints reveal the tension between them. The positive and negative outcomes help explain the nuance in how the affordances and constraints interact.

Finally, the Affordance-Constraint-Outcome model interprets the relationships between the features, affordances, constraints, and outcomes. When breaking the individual constructs into emotional, behavioral, and physical components, the model, and its associated findings, furthers the NAF perspective and affordance theory by showing, not just the nuance in the drivers, affordances, and outcomes, but the tension between the affordances and constraints as well.

APPENDIX

APPENDIX

Supplementary Tables

Table A.1. Emotions in IS Literature Review

Author	Emotion	Operational Definition	IS Stimulus	Anticipatory or Impact Period[3]
		Anticipatory Emotions in Response to Non-IS Stimulus		
Anderson and Agarwal 2011	Negative	Anticipated in that the emotions are not currently experienced, but are expected to be at some point in the future	No	Anticipatory
		Impact Period Emotions in Response to Non-IS Stimulus		
Fehrenbacher 2017	Angry and Happy	Receiver's emotional valence to a requestor's facial expression	No	Impact
Hong et al. 2016	General	Percentage of emotional words out of total words as indicated by the Linguistic Inquiry and Word Count (LIWC2015) software	No[2]	Impact
		Anticipatory Emotions in Response to IS Stimulus		
Beaudry and Pinsonneault 2010	Multiple	A mental state of readiness for action that arises from the announcement of the imminent deployment of a new IS	Yes	Anticipatory
Chin and Gopal 1995[1]	Enjoyment	The extent to which the activity of using the computer is perceived to be enjoyable in its own right, apart from any performance consequence	Yes	Anticipatory
Tsai and Bagozzi 2014	Anticipated Emotions	Forward looking affective reactions where virtual community members imagine the emotional consequences of contributing or not contributing to an online community	Yes	Anticipatory

(continued)

Author	Emotion	Operational Definition	IS Stimulus	Anticipatory or Impact Period[3]
Jingguo Wang et al. 2017	Phishing Anxiety	A fearful feeling triggered when individuals believe they are vulnerable to phishing attacks and the consequence of being compromised is high	Yes	Anticipatory
		Impact Period Emotions in Response to IS Stimulus		
Al-Natour et al. 2011	Perceived Enjoyment	A belief about the emotional outcomes of the behavior of interacting with the IS stimulus	Yes	Impact
Bhattacherjee 2001[1]	Satisfaction	Users' affect with (feelings about) prior (online banking) use	Yes	Impact
Brown et al. 2004[1]	Anxiety	One's level of fear of apprehension associated with actual or anticipated use of IT to communicate with others	Yes	Impact
Burns et al. 2019	Happiness, Interest, Sadness, and Anxiety	Four emotions from Beaudry & Pinsonneault's (2010) framework to show reactions related to opportunity or threat, and perceived lack of control or control	Yes	Impact
Cenfetelli 2004[1]	Positive vs. Negative	Positive emotions: Fondness, happiness, joy, contentment; Negative emotions: Unhappiness, worry, anger, nervousness, regret, disgust, fear, anxiety, irritation	Yes	Impact
Chen et al. 2019	Positive emotional cues vs. Negative emotional cues	Tries to put people in a hedonic (positive or negative) state to increase their responsiveness to information	Yes	Impact
Compeau and Higgins 1995[1]	Anxiety & Affect	The feelings of apprehension one experiences and the enjoyment one drives from using computers	Yes	Impact
Compeau et al. 1999[1]	Affect & Anxiety	The enjoyment one derives and the feelings of apprehension one experiences using computers	Yes	Impact
Davis et al. 1992[1]	Enjoyment	The extent to which the activity of using the computer is perceived to be enjoyable in its own right	Yes	Impact

(continued)

Author	Emotion	Operational Definition	IS Stimulus	Anticipatory or Impact Period[3]
Dissanayake et al. 2019	Sadness, anger, and fear	A feeling of lost and disadvantage, evoked due to injustice, conflict, humiliation, negligence, or betrayal, and a response to impending danger	Yes	Impact
Hibbeln et al. 2017	Negative	Brief feelings of unhappiness associated with the use of an external computer system	Yes	Impact
Jarvenpaa and Standaert 2018	Emotional Tensions	Mechanisms that can push beyond an actor's consciously and unconsciously imposed limits to expand perceptions of possibilities.	Yes	Impact
Kim et al. 2004[1]	Pleasure & Arousal	The degree to which a user feels good, happy, excited, or stimulated	Yes	Impact
Kordzadeh and Warren 2017	Affective commitme nt	Emotional attachment to a group	Yes	Impact
Koufaris 2002[1]	Enjoyment	One of the emotion components of flow which is the holistic sensation that people feel when they act with total involvement	Yes	Impact
Liang et al. 2019	Negative	Emotion-focused coping is uses to pacify or control emotions aroused by an IT security threat	Yes	Impact
Ormond et al. 2019	Frustration	The feeling one experiences when progress towards a goal is impeded	Yes	Impact
Park et al. 2019	General	Feelings that individuals experience and can share with others	Yes	Impact
Stein et al. 2015	Multiple	Arise as an induced affective state as a reaction to situational events that are appraised to be relevant to a person's needs, goals, or concerns. Can be mixed	Yes	Impact
Teubner et al. 2015	Immediate emotions and arousal	Skin conductance response and heart rate	Yes	Impact
Todman and Monaghan 1994[1]	Anxiety	The pressure felt when interacting with a computer	Yes	Impact
Trevino and Webster 1992[1]	Flow	A subjective psychological experience that characterizes the human–computer interaction as playful	Yes	Impact

(continued)

Author	Emotion	Operational Definition	IS Stimulus	Anticipatory or Impact Period[3]
Venkatesh 1999[1]		The extent to which the activity of using the computer is perceived to be enjoyable in its own right	Yes	Impact
Venkatesh 2000[1]	Anxiety, Enjoyment, & Playfulness	One's apprehension, perceived enjoyment, and spontaneity when using computers	Yes	Impact
Venkatesh et al. 2003[1]	Affect & Anxiety	One's linking for computer use and feelings of apprehension that one experience	Yes	Impact
Webster and Martocchio 1992[1]	Anxiety and Playfulness	One's tendency to be apprehensive or interact spontaneously with using computers	Yes	Impact
Webster et al. 1993[1]	Flow	A subjective psychological experience that characterizes the human–computer interaction as playful	Yes	Impact
You and Robert 2018	Emotional Attachment	A basic, naturally-occurring human need that develops an emotion-laden target-specific bond between a person and specific object	Yes	Impact
Zhang 2013	General	An induced affective state that emphasizes a person's subjective feeling in response to an IS stimulus	Yes	Impact
Yin et al. 2014	Anxiety and Anger	The emotional states that motivates a person to avoid potential hard from an ambiguous state and alleviate harm attributed to others	Yes[2]	Impact

Note: [1] Denotes articles that were included in Beaudry and Pinsonneault's (2010) literature review. [2] Denotes articles where the stimulus is not studied or explained in detail. The yes/no categorization is based off the assumed stimulus to the studied emotions as the stimulus is not explicitly discussed in the article. [3] indicates the emotions are studied either during the impact period or during the post-impact period.

Table A.2. Emotional Driver Selective and Open Codes

Open Codes	Selective Codes
Ease fears while working nights	Fear
Fear of vaccine side effects	Fear
Fear to leave alone	Fear
General fear	Fear
Nervous as first-time parent	Fear
Rainbow baby	Fear
Scared of SIDS	Fear
Scared of SIDS know IS doesn’t prevent	Fear
Anxious while infant sleeps	Anxiety
Anxious when sick	Anxiety
Guilt if you didn’t do everything for infant	Mom Guilt

Table A.3. Behavioral Driver Selective and Open Codes

Open Codes	Selective Codes
Constantly checking on infant	Caregiver sleep issues
Could not sleep	Caregiver sleep issues
Baby rolling over	Infant sleep issues
Infant only sleeps on belly	Infant sleep issues
Noisy sleeper	Infant sleep issues
Used to data from hospital	Already conditioned to Data
Used to data from previous child	Already conditioned to Data
Used to NICU data	Already conditioned to Data

Table A.4. Physical Driver Selective and Open Codes

Open Codes	Selective Codes
Medical scare in hospital	Pre-existing condition
NICU baby	Pre-existing condition
Medical condition	Pre-existing condition
Previous chocking episodes	Pre-existing condition
Sick child	Pre-existing condition
SIDS Scare	Pre-existing condition
Premature birth	Preemie
Moved baby out of room	Transitioning
Transitioning to crib	Transitioning

Table A.5. Positive Emotional Outcome Selective and Open Codes

Open Codes	Selective Codes
2^{nd} set of eyes	Anxiety relief
Less Anxiety	Anxiety relief
Peace of mind	Anxiety relief
Peace of mind from a distance	Anxiety relief
Sense of security	Anxiety relief
Comforting to know vitals	Comfort
Excitement with extra data	Comfort
Different alarms prevent false alarm stress	Contentment
False alarms are worth sense of security	Contentment
Grateful for owlet	Gratefulness
Love the sock!	Gratefulness
Love tracking sleep patterns	Gratefulness
Regret not getting it sooner	Gratefulness

Table A.6. Positive Behavioral Outcome Selective and Open Codes

Open Codes	Selective Codes
Baby sleeps just fine	Improves sleep
Better sleep	Improves sleep
Better sleep (for both)	Improves sleep
Don’t have to check on them anymore	Improves sleep
Don’t have to physically check infant	Improves sleep
Good visual	Improves sleep
Ability to get other things done	Virtual checking on infant
Ability to use while at work	Virtual checking on infant
Freedom	Virtual checking on infant
Increased distance	Virtual checking on infant
React to red alarm	React when needed
Still check breathing	React when needed
Alarms wake you up	React when needed
Combats SIDS	React when needed
Sleep in other room	Transition infant
Move out of room	Transition infant
Know when in deep sleep	Observe sleep patterns
Tracking sleep	Observe sleep patterns
Travel with it	Travel

Table A.7. Positive Physical Outcome Selective and Open Codes

Open Codes	Selective Codes
Diagnosed condition	Identified medical need
Discovered O2 turned off	Identified medical need
Reduces SIDS	Identified medical need
Saved life	Identified medical need
Self-diagnosed	Identified medical need
Accurate	Works as expected
Better or same as medical monitor	Works as expected
Better than or just as good as medical device	Works as expected

Table A.8. Negative Emotional Outcome Selective and Open Codes

Open Codes	Selective Codes
False sense of security	Increased anxiety
Worse anxiety	Increased anxiety
Worried about radiation	Increased anxiety
Worried about reliability	Increased anxiety
Annoyed with app	Annoyance/Frustration
Annoyed with errors	Annoyance/Frustration
Annoyed with inaccurate readings	Annoyance/Frustration
Disappointed with reliability	Annoyance/Frustration
General frustration	Annoyance/Frustration
Sad	Annoyance/Frustration
Upset	Annoyance/Frustration
Privacy questions	Ethical Questions
Unethical	Ethical questions

Table A.9. Negative Behavioral Outcome Selective and Open Codes

Open Codes	Selective Codes
Infant doesn’t sleep well	Diminished sleep
Wakes the infant	Diminished sleep
Worse sleep	Diminished sleep
Addicted to knowing	Data conditioning
Can’t imagine not using	Data conditioning
Continuous checking of data	Data conditioning
Want to wear 24/7	Data conditioning
Forget to charge	Forgetfulness
Forget to put on infant	Forgetfulness
Forget to turn on	Forgetfulness
Not safe sleep practices	Unsafe sleep practices
Pediatrician recommended not using	Advised against continued use

Table A.10. Negative Physical Outcome Selective and Open Codes

Open Codes	Selective Codes
False alarm (but for real reasons)	False alarms
False negative	False alarms
False positive (false red)	False alarms
Unknown alarm	False alarms
Hurt infant	Injured infant’s foot

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