MASTER'S THESIS

Ability of Audio Feedback in E-books to compensate for haptic attachment to print books

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Ability of Audio Feedback in E-books to Compensate for Haptic Attachment to Print Books

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Abstract

Following a significant boom in popularity, the growth of the e-book industry has underperformed expectations. Despite the advantages of e-books, physical print media retains preference amongst readers. Research on behavioural economics, in particular with regard to the psychological importance of touch and sensory input, suggests that this resistance to e-books may be indicative of a bias towards valuing tangible goods over digital. Through use of interactive applications, however, a sense of imagined touch can compensate for this discrepancy. Sensory perception can be influenced by adjacent senses, and one way this is possible is through the use of sound effects synchronised with haptic interaction. For this study it was hypothesised that interactive audio feedback, when implemented in a touch screen e-reader, would magnify the perception of e-book ownership felt by that user. The experiment involved participants using a purpose built touch screen e-reader web application. Whenever a user touched the screen to interact with the e-book, the application would emit a certain sound effect. Four treatment groups of participants tested four different sounds: a high pitch tone, a lower pitch tone, a *pink* noise profile and a *blue* noise profile. A fifth group was treated with no sound effect. After exposure to the e-book, the participants were asked to specify a price at which they would sell it as a measure of perceived ownership. The results showed that the hypothesis was partially confirmed: one sound, the high pitch tone, correlated with a significant increase in perceived value from the control group. All other sounds demonstrated no notable change. The conclusion that a certain feedback sound in an e-book on a touch screen may in fact intensify feelings of ownership has great implications for touch screen user interface design and interactive touch screen applications in general. Moreover, the findings are consequential to the future of e-book design. Whereas the paper book metaphor has served as the dominant design paradigm for e-books, the impact of sensory feedback suggests that e-books may cultivate a greater sense of attachment with readers by embracing the interactivity afforded by modern mobile technology.

Statement of Originality

This thesis is submitted to Bond University in fulfilment of the requirements of the degree of Master of Philosophy. This thesis represents my own, original work towards this research degree and contains no material which has been previously submitted for a degree or diploma at this University or any other institution, except where due acknowledgement is made.

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Key Terms

Digital: Information stored as digital signals intended for access and manipulation by computers.

E-book: Any digital interface intended to match the form and function of a book.

E-reader: Any dedicated computer hardware or application intended to access e-books.

Feedback: The sensory output from an interactive system to coincide with input.

Haptics: Any interaction conducted by way of touching.

Illusion: Any false perception arising from a misinterpreted sensory stimulus.

Phenomenon: An event or circumstance perceivable by way of human senses.

Tangibility: An attribute of an object, physical or otherwise, that describes the extent to which it is perceivable by the senses, particularly in regards to touch and haptic perception.

The endowment effect: An economic hypothesis regarding the tendency of people to overvalue objects in their possession, explaining that people *endow* their possessions with innate value simply by possessing them: An effect that is also referred to as a sense of ownership or attachment.

WTA: Measured in currency, a person's willingness to accept payment for a particular good or service.

WTP: Measured in currency, a person's willingness to pay for a particular good or service.

1. Introduction

1.1 The phenomenological world

"In many visually guided motor tasks, such as drawing, needlework, automobile driving, and surgery, the importance of tactile and kinaesthetic feedback is often underappreciated until it is no longer available" (Perreault & Cao, 2006, p.574).

In the early stages of infant development, humans gain the mental capacity to understand that objects outside of immediate perception do not in fact cease to exist. This ability is referred to as object permanence (Murray, Hufnagel, Gruber, & Vonèche, 1979). Although we take this ability for granted in adult life, it is not infallible. Subbotski and Trommsdorf (1992) describe it as "the capacity of some entity, be it mental or physical, to conserve its stability in an individual's mind" (p. 63).

Humans rely on the clarity of the senses of sight, touch and taste to preserve this stability. For example, it may be an unsurprising revelation to some that we find it easier to spend electronic money than physical cash. *Transparent* forms of payment, such as credit cards and bank transfers, are in fact proven to induce greater willingness to spend money and a lowered psychological barrier for sacrifice (Raghubir & Srivastava, 2008). A common term used to describe the extent to which such an event or circumstance is cognisable by the senses is *phenomenality*. In modern philosophy, the word is closely associated with the works of Immanuel Kant (1929), who articulated in his *Critique of Pure Reason* that the universe as experienced by humans consists only of the phenomenological. Phenomenality has great significance to the human experience, shaping one's perception of not only the phenomenological realm, but also the *noumenal*; the realm of ideas and beliefs, the transcendent and intangible. In the case of digitisation - the process by which analogue phenomena are converted into digital information - the true significance of phenomenality is often overlooked.

Emerging from what was once regarded as the realm of experimental avant-garde technology, *e-books* have enjoyed a period of substantial growth in the past decade.

These *electronic books* have been ambiguous in description, with definitions coalescing around the simple concept of a traditional print-bound physical book in a digital form. Unlike physical print books, however, the affordances of digitisation allow e-books to transcend the limitations of physical space. E-books can be stored in large quantities in a very small amount of space. Utilising the internet, they can be transported around the world in an instant, and they can be transformed, in the sense that they are copied, deleted or otherwise altered, with ease. In spite of their numerous benefits, e-books have faced resistance in regard to replacing the traditional print book. Consumers have shown they are not willing to pay the same price for an e-book that they would for a print book (Oestreicher-Singer & Sundararajan, 2004). Explanations for this have ranged from cultural to rational, but one element that has been consistently overlooked is the importance of phenomenality and tangibility.

1.2 Digital literature

Digital technology has challenged the traditional structure of the book publishing establishment in more ways than one. Whereas in the past, a *reader*, and in fact the act of *reading*, would be considered solely as pertaining to a person who read and bought books, today the term is far more ambiguous. Digital technology has ensured that content today can take many different forms; from news articles, to games, to blogs, and tweets. The changing landscape of how literature is consumed demands reassessment of the book publishing business model and indeed the very concept of what constitutes a book (Tian & Martin, 2011). The circumstances of today are in many ways similar to the effect of the Gutenberg press, the capabilities of which allowed faster and wider dissemination of information to the benefit of society (Dittmar, 2011). An increase in the accuracy of replication had the effect of emphasising the value of content and authorship, a trend embodied by development of copyright law (Cotter, 2014). This transition was considered the earliest notion of a *knowledge economy*, a concept that would only become more prominent with each successive innovation in communications technology, culminating in the creation of the internet circa. 500 years later (Cope & Freeman, 2002).

From the 1980s through to the 1990s, *digital literature*, a new form of literary work pertaining to a digital environment, had established a small audience of early adopters dedicated to a few experimental artists. Such innovators came to be the early adopters of e-readers; portable devices intended for the specific task of accessing e-books (Subba Rao, 2001). The first of these devices appeared in the consumer electronics market in 1998, led by Softbook and NuovoMedia's Rocket e-book reader (as seen in Figure 1.1) (Richardson Jr & Mahmood, 2012). E-readers of this period were stunted by the contemporary technological capabilities of mobile technology and user experiences were mixed. The Rocket e-book reader, for instance, while designed to be the size of a paperback book, was a device known to induce wrist fatigue due to its weight (Manley & Holley, 2012). As a result of the cost and general inefficiency, e-publishing was relegated to an unwieldy and unstable developing industry. The bursting of the dot-com bubble in 2000 struck a significant blow to numerous startup e-book services which were unable to establish a sustainable business model (Machovec, 2002). Commentators maintained that the e-book had yet to be fully realised, recognising such factors hindering their uptake as the poor quality of contemporary e-reading devices and a lack of adequate DRM (digital rights management) support (Hillesund, 2001).

Figure 1.1: NuovoMedia's Rocket E-book Reader
available at http://wiki.mobileread.com/wiki/File:Rocketebook.jpg under a Creative Commons Attribution Non-Commercial Share Alike license

In subsequent years, attitudes towards e-books in technology research fluctuated in optimism. Commentators maintained digital books represented a significant cost-benefit advantage over their physical counterparts (Bunkell & Dyas-Correia, 2009). Bolder predictions prophesied the eventual superseding of print books by e-books, corresponding with the cannibalisation of market share following the eventual *e-book revolution*. President of publishing house *Simon & Schuster*, Jack Romanos, once stated that "the e-book revolution will have an impact on the book industry as great as the

paperback revolution of the 60s," (Kirkpatrick, 2000). Commentators invoked the term "cultural and technological shift" (Sheehan, 2013; p.1), referencing the outmoding of print in favour of digital. Michael Hart, founder of Project Gutenberg and often credited as the creator of the e-book, blamed the flagging growth of the industry during this period on the financial concerns of book publishers:

> Virtually all the million-dollar corporate e-book ventures, both hardware and software, have been designed with business plans that were fundamentally designed to charge as much as possible for e-books and/or e-book readers, often to the point of charging more for e-books than their paper counterparts, even though there were no costs for printing, warehousing, shipping, etc. and that editing them was so much easier. As a result, each of these business plans was ultimately designed to fail, perhaps intentionally, out of a fear that the paper books market might go the same direction as when music switched from vinyl to CDs starting only 20 years ago, and finishing very quickly. (Ashmore & Grogg, 2005; p.42)

E-books nevertheless found a foothold with the debut of *Amazon*'s Kindle in 2007 bringing about a significant uptake in adoption. In addition to presenting a satisfying ergonomic experience that resonated with users, unlike any previous e-reader, the Kindle was notable for breaking away from e-reader conventions in terms of content distribution. While contemporary devices such as the *Sony* Portable Reader required users to load content by use of a USB connection, a Kindle had the capacity to access the internet wirelessly; although users could only purchase copyrighted material from the *Amazon* bookstore (Manley & Holley, 2012).

By reducing prices of e-books offered through their content distribution system, *Amazon* spurred a rapid period of growth that would last several years. Although under-pricing e-books would prove detrimental to the value proposition of print books, resulting in negative spill over effects for book publishers, *Amazon* was able to offset the ensuing profit deficit through the sales of their Kindle device (D'Souza, 2015).

By early 2009, e-books had gained significant momentum carried by the Kindle, and in 2010, uptake accelerated due to, among other factors, the launch of *Apple*'s iPad (McCraken, 2013). In the subsequent year, trade publishers increased their e-book production rate from 50% to 76%. Despite its then recent introduction in a long standing industry, 1 in 10 publishers of e-books received more than 10% of their revenue from e-book sales (Hane, 2011). In just the third quarter of 2010, e-book sales rose from $88.7 million to $119.7 (Manley & Holley, 2012).

In hindsight, the early optimism for e-books induced rather than predicted the e-book revolution (Striphas, 2006). By 2009 it had become apparent that the upward trajectory of e-books would not adversely affect the readership of print (Velde & Ernst, 2009). The e-book boom did not last, and as demand stabilised, growth stalled considerably leading into 2013 (Greenfield, 2014).

1.3 Ownership

In explaining the stalled growth in e-books, little attention has been paid to what might perhaps be the most important factor of all: tangibility (Walsh, Asha, & Sprainger, 2007). The reading of a physical book as a multisensory experience is often overlooked, but it is a sensation not easy for their digital counterparts to replicate (Young, 2001; Mangen, 2008). While vision, hearing and touch are all considered important senses to the study of HCI (human computer interfaces) (Dix, Finlay, Abowd & Beale, 2004), the sense of touch is unique in its *proximity*, being the only sense experienced by way of contact with one's skin (Krishna, 2010). There is an understanding amongst readers that characterises this notion as a kind of *thingness* that gives ownership greater potency (Staiger, 2014). Readers from a breadth of demographics: young and old, technologically literate and illiterate, have indicated a preference for print books pertaining to an elusive, hedonic sense of ownership. This sense, more associated with physical books, can serve as an explanation for the resistance to e-books as replacements for print.

The link between tangibility and ownership has been explored to great detail in economics. The most prominent hypothesis in quantifying the magnitude of ownership

felt towards a particular object is known as the *endowment effect*. This effect describes the phenomenon by which humans tend to overvalue items in their possession, yielding a ratio between an individual WTP (willingness to pay) and WTA (willingness to accept payment) for a particular good. Using the endowment effect as a framework, it is evidenced that touching and manipulating an object in physical space does in fact have an observable correlation to the intensity of the perceived ownership (Peck & Shu, 2009). For this reason, consumers do not feel the same attachment to digital data, being intangible and transient, as they do to physical possessions.

Central to the goal of facilitating an endowment effect with digital objects is the fallibility of human senses. When our senses contradict and alter our perception, it is referred to as an illusion. Such illusions, utilising haptic imagery to sustain an *imagined* sensation of touch, have been shown to replicate the impact of real, physical touch on the endowment effect, the extent depending on the vividness of that imagery (Peck, Barger, & Webb, 2013). This can be accomplished by as little effort as closing one's eyes and imagining the touching an object. Interaction with a displayed product though a touch screen device, by extension, can facilitate greater sensations of ownership and subjective value than possible with a traditional mouse-controlled computer (Brasel & Gips, 2014).

What hasn't been considered in a substantial measure is the usage of audio as a sensory channel in sustaining imagined touch, and hence enhancing the endowment effect to the degree of physical contact. Given the capacity for sound to influence haptic perception, as demonstrated by experiments such as the parchment-skin illusion (Jousmäki & Hari, 1998) to be discussed in detail in the literature review, it is worth investigating to what extent audio feedback effects, when synchronised with a user's interaction with a touch screen, can establish a greater sense of ownership.

1.4 Purpose of Research

The resistance toward e-books is believed to be a product of the innate phenomenality of print books (Staiger, 2014). Addressing this state of affairs and offering subsequent insight into effective e-book design serves as the purpose of this study. It is

hypothesised that interactive audio feedback can facilitate a greater sense of tangibility, and as a result, perceived ownership in e-books. The primary research question is:

- To what extent does audio feedback impact perceived-ownership of an e-book?

In addressing this question, the study examines the impact interactive audio feedback in e-books has on the intensity of the endowment effect regarding that particular e-book. In this case, the nature of the feedback sound serves as the independent variable. Impact is measured as the variation of a person's willingness to accept money as payment for the e-book; the dependent variable. An experiment that invites participant interactivity with an e-book is required to test such a correlation. This gives rise to a secondary dependent variable: the exposure and subsequent interactivity engaged in by the participant. Two supplementary research questions were also conceived for the sake of contextual information.

- To what extent does interactivity impact perceived ownership of an e-book?
- To what extent does audio feedback impact interactivity with an e-book?

These research questions are intended to explore the relationships between the three variables (as depicted in Figure 1.2) in order to obtain a more comprehensive understanding of the phenomenon.

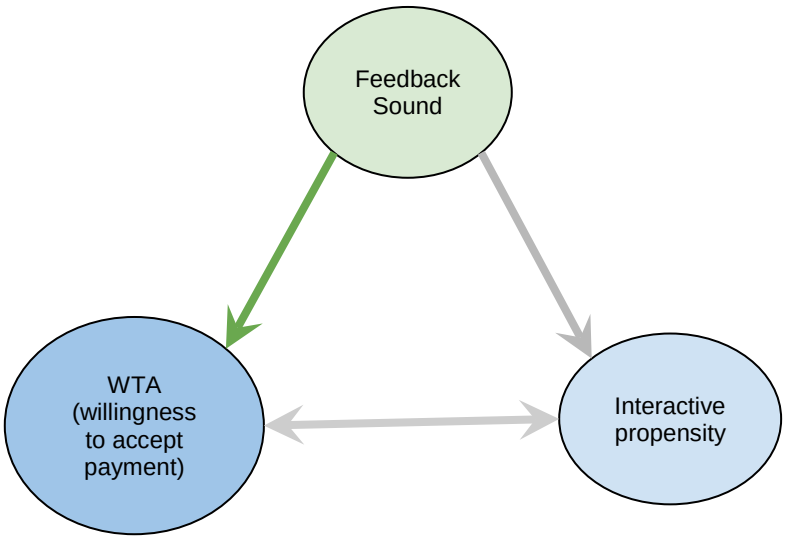

Figure 1.2: Variable relationships

1.5 Contribution to field

The study will contribute not only to the field of research exploring consumer perceptions of e-books and e-readers, but also the field of HCI with respect to e-books and e-readers. E-book developers and publishers will benefit from the research by sharing a greater understanding of how readers perceive the value of e-books in comparison to print. The findings will offer greater insight into how designers can leverage interactive features to establish a greater sense of tangibility and attachment. Any outcomes will have implications regarding the market for interactive *enhanced* e-books, which despite the growing reliance on interactive multimedia devices for e-reading, have as yet been unable to make significant market headway against simple digital editions (Costanzo, 2014).

The exploration of the endowment effect in terms of interactive applications will also benefit online retail, particularly in regard to touch screen interfaces. Online businesses concerned with creating value for their customers can consider this research valuable for its consideration of the endowment effect in a digital context. Any findings will provide insight into how an interactive application with sensory feedback can foster greater feelings of ownership, much like the role of touch in physical retail, leading to greater valuation and purchase intentions resulting from the shopping experience (Peck & Childers, 2003).

Audio feedback as a potential tool for inducing the impression of tangibility would in fact have applications in a breadth of touch screen interfaces. User interface design will benefit from establishing a greater sense of attachment by utilising the endowment effect. Digital advertising is one industry in which this would be prevalent.

For its implications to interactive applications, video game design is another field in which the conclusions of this research can be beneficial. The growth of mobile games invites the consideration of touch screen interfaces as game controllers, and so the findings of this study in regards to amplifying the endowment effect on touch screen

devices should be advantageous. Mobile games should be able to leverage audio feedback as a way of creating attachment for players not possible on any other platform.

1.6 Structure of Dissertation

This dissertation is divided into six chapters, each representing a different stage of the research. In this first chapter, the introduction, an overview of the field as well as the intentions of the study are articulated. A philosophical basis regarding the merits of digitisation and phenomenology is established as the foundation of the research. Some key terms and concepts that are used throughout the dissertation are also discussed here.

In the following chapter, a comprehensive literature review of all the related study is compiled, with the goal of identifying a particular gap in understanding. This chapter is divided into three sections regarding three core topics of the study. The first of these is a review of the key literature examining the notion of value. The second part pertains to reader preferences and experiences between electronic and physical books, and how it is evaluated by individuals. In the third part, drawing upon the first and second, the use of sensory illusions to create an imagined sense of value and tangibility is discussed.

In the third chapter, the methodology of the experiment is specified. This methodology is informed by the literature review and designed to address the research questions. The study will follow a quantitative experiment in which data is collected using a simulated e-book application. Chapter 4 contains a compilation of all the related data, and subsequent analysis, in tabulated form. This data is included for its relationship to the research questions and with reference to the three variables: the feedback sound, WTP value, and interactivity propensity.

Chapter 5, the discussion, is concerned with examination of the results in regards to answering the research questions. Referring to the previous chapter, the outcomes of the experiment are interpreted for their implications and validity. The literature review is consulted for this task, explaining the results in context of previous research. In Chapter 6, the conclusions obtained from the discussion are listed in the full context of the research purpose and literature review. Any subsequent avenues for study are made

apparent in the discussion, and any limitations of the conducted study, are also highlighted.

1.7 Summary

After an initial boom, the e-book industry has faced resistance in more recent years. Readers have indicated an unwillingness to adopt e-books as replacements for print media, and among the reasons for this is an innate preference for physical and tangible media. Interaction with the phenomenological world is a significant aspect of the human experience, reflected in our tendencies to seek physical contact as a way of understanding our environment. Given this, readers place greater value in physical books as possessions. By way of synchronised auditory illusion, it may be possible to compensate for the lack of a sensory relationship with e-books and instil a greater sense of tangibility. Exploring this possibility is the topic of this dissertation. An experiment will be conceived that is capable of measuring the effect of audio feedback sound on perceived ownership in a touch screen e-reader application. This will be done by exposing the participant to a particular sound synchronised with interactivity before requiring a specified selling price. In the following chapter, the relevant literature will be reviewed and examined. These topics will contextualise perceived value, e-books, and techniques of conveying an illusion of tangibility in a user experience.

2. Literature Review

2.1 Introduction

The research questions of this study relate to a great breadth of literature, spanning from economics to user interface design. Three main topics are the target of this literature review: the concept of value; the practice and culture of e-reading; and illusory tactility. At the intersection of these topics lies the gap in research to be addressed by this study.

2.2 Value

The concept of value is elusive and there exists a plurality of opinions regarding what it constitutes. In the field of economics and retail, it is most often considered to be of a perceptual nature, regarding a perceived losses and gains (Day & Crask, 2000). When seen as a subjective judgement of usefulness resulting from consumption, it overlaps with the economic definition of *utility* (Zeithaml, 1988). One of its more comprehensive definitions was proposed by Woodruff (1997): "Customer value is a customer's perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer's goals and purposes in use situations" (p.142).

Value as a subjective measure is conflated with *perceived* value. It is thought of as reflective of a consumer's judgement regarding a product's overall excellence or superiority (Zeithaml, 1988). Intensifying perceived value is both the essential desired outcome of any marketing activity and a primary motivation for engaging with marketing relationships (Mathwick, Malhotra & Rigdon, 2001).

Although the concept of value itself is subjective and idiosyncratic, most expressions of perceived value are generalised into one definition: an overall assessment of a product's utility based on perception of potential sacrifice and gain (Zeithaml, 1988). The ambiguity of the concept has resulted in confusion with other related terms such as *quality*, *satisfaction* and *values*, although it is critical to note that they are by no means synonymous (Day & Crask, 2000). Value represents a higher level of abstraction than

quality, a term that refers more to the objective or actual quality of a product, encapsulating a more objective view of potential benefits outside of the context of required sacrifice (Zeithaml, 1988). Consumers tend to judge quality through various metrics, and one of the more reliable gauges is a product's price, in particular when no other information is available (Olson, 1976). A customer might interpret a higher price, when compared to a cheaper alternative, as a higher quality product. Other cues for perceived quality include brand names (Gardner, 1971). Famous brands have the advantage on trust as a virtue of recognisability.

Quality can be invoked as an objective measure to describe technical superiority in quantifiable terms. As all quality is perceived by way of sensory instruments, the existence of true objective quality is contentious and the usefulness of the term is disputable (Zeithaml, 1988). As illustrated in Figure 2.1, a sense of perceived quality and perceived value are formed by an evaluation of intrinsic and extrinsic attributes. Intrinsic attributes represent the functional elements of a product, whereas extrinsic attributes refer to emotional attachment.

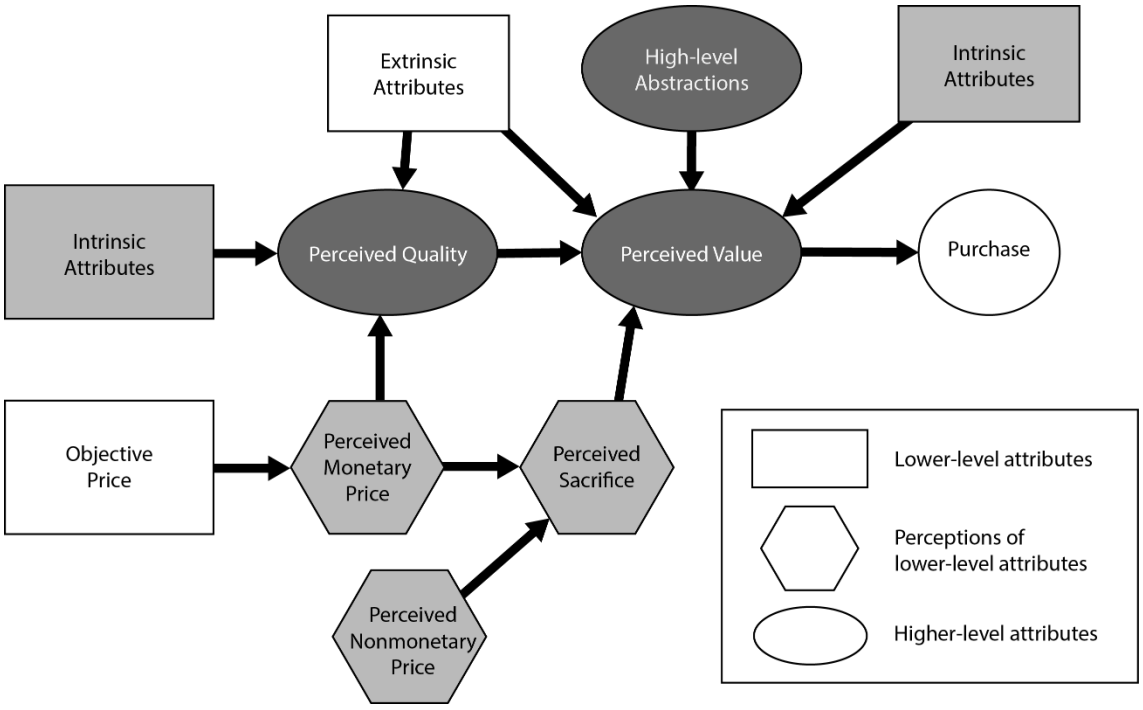

Figure 2.1: A model of price, quality and value.
(Adapted from Zeithaml, 1988, p.4.)

Price, in the model of perceived value, is one of the sacrifices willing to be given in exchange for the perceived net benefit of a product. Costs of time, cognitive stress, and other expenditures of effort are often ignored although they also are considered as sacrifices by consumers (Zeithaml, 1988). By way of illustration, consider the value of a well-established soft drink brand such as *Coca-Cola*, which may be preferred to a generic corresponding store brand for its positive connotations. The cognitive concept of a product is retained at multiple levels of abstraction amongst consumers. Whereas the base level is the simple attributes of a product, higher levels are concerned with value as a more complex assessment of the product in regards to the payoff provided to the consumer (Zeithaml, 1988).

The concept of perceived value is fundamental to the long term success of businesses and any organisations dealing in products and services. While the term is often misused in the social sciences, defining and indeed measuring value in marketing literature has proved divisive and inconsistent due to the inherent complexities of how consumers perceive value (Sanchez-Fernandez & Iniesta-Bonillo, 2007). Attempts to consolidate this complexity conclude that consumers are value driven by measures which can be both hedonic and utilitarian in nature (Sweeney & Soutar, 2001).

Perceived value can thus be thought of in four dimensions: emotional, social, quality/performance and price/value for money. Emotional value refers to any benefit that results from the feelings generated. Social value is the capacity of a product to influence one's sense of self. Price/value for money value is the net utility of the product in consideration of the sacrifices made, while quality/performance is the gross utility derived from a product in consideration of its quality and performance (Sweeney & Soutar, 2001).

The processes by which consumers judge value of a product is likewise a topic of interest. Central to this is the study of human decision making, the expected human behaviour when faced with uncertain outcomes, and significance of a cost/benefit

equilibrium. The psychological understanding of this process has invited several interpretations over the years.

2.2.1 Expected utility value

Traditional economics has considered decision making as a process of rational deduction where an actor in such a system can be characterised as wishing to maximise their welfare. Classical notions of rationality might refer to the max-min rule, referring to a process by which a decision would be made based on the best of the worst possible outcomes; the probabilistic rule, referring to the weighting of a possible outcome by known probability, and the certainty rule, referring to the selection of a course of action as having the highest expected outcome when the outcomes are certain (Simon, 1955). The expected utility hypothesis represents a dominant theory in regards to rational choice in its explanation for the decisions made by individuals given uncertain outcomes. According to this principle, actors are only concerned with maximising *expected utility* by considering the probable outcome of a course of action weighted by the probability of its occurrence.

Contrary to expected utility, the assumption of actors as perfectly rational has been noted as inconsistent with observable behaviour in the real world. Noted violations of expected utility theory are numerous, and demonstrate that decisions tend to be influenced more by subjective perception and judgement than logical deduction (Tversky & Kahneman, 1986). The understanding of people as irrational actors is the basis for what is known as behavioural economics, which itself is comprised of key founding assumptions: *bounded rationality*, referring to limitations on human cognition both natural and circumstantial; *bounded willpower*, referring to the tendency of humans to ignore their long-term interests, and *bounded self-interest*, referring to the propensity of humans to act according to empathy (Posner, 1998).

2.2.2 Prospect value

One of the most cited criticisms of expected utility theory in particular is articulated by Kahneman and Tversky (1979) in the formulation of *prospect theory*. Devised as a psychologically cohesive alternative to the expected utility hypothesis, prospect theory

contends that individuals perceive outcomes as gains and losses relative to a current reference point as opposed to a consequential measure of welfare. Choices are not necessarily weighted by their probability of occurring, but rather are decided by an individual's reference point. As such, prospect theory indicates that actors are irrational by the standards of expected utility theory. This notion of *reference dependence* also challenges what is known as the *Coase theorem*, a hypothesis that contends reference points do not factor into the final allocations of property rights (Levy, 1997).

Central to the premise of prospect theory is the phenomenon of *loss aversion* (Tversky & Kahneman, 1992). This term refers to the tendency of people to perceive potential losses as costlier than an equivalent gain would be beneficial. Representing an imbalance between potential gains and losses, tests of loss aversion indicate, in general, that losses have twice the psychological weight of gains (Tversky & Kahneman, 1992). *Status quo bias*, a preference for individuals to maintain one's current reference point in spite of both losses and gains, is a similar phenomenon considered to be a manifestation of loss aversion (Kahneman, Knetsch & Thaler, 1991).

2.2.3 Endowment value

As the prevalence of loss aversion suggests people fear loss more than they desire gain, it follows that people value things they already own more than things that they don't. This hypothesis is known as the endowment effect (Kahneman, Knetsch & Thaler, 1990). Congruent with loss aversion, the endowment effect has been demonstrated to induce overvaluation of possessions by double their respective buying price (Levy, 1997). The understanding of endowment as a manifestation of loss aversion is affirmed by the observation that willingness to trade is affected by the comparability of traded objects, given that people experience a greater magnitude of endowment the more dissimilar the objects of trade are. A wine seller, as is the case in one such study, is more reluctant in trading a wine from a different country than from his own (Van Dijk & Knippenberg, 1998).

The process of endowment is understood to become effective almost instantaneously. However, longer durations of exposure and possession correlate with an increased sense

of attachment both in terms of attractiveness and perceived value (Strahilevitz & Loewenstein, 1998). Although examination of items by potential customers in retail lasts no more than 10 seconds, an additional 20 seconds can correlate with a higher valuation (Wolf, Arkes, & Muhanna, 2008). The resulting attachment can be moderated by emotional states. An individual in a positive emotional state tends to experience the endowment effect at a greater magnitude. Negative emotions can have a similar but detrimental impact (Lin, Chuang, Kao & Kung, 2006). An individual experiencing sadness, for example, would specify a lower magnitude of endowment.

The methodologies concerning observation of the endowment effect tend to adhere to an exercise adapted from Knetsch (1989). Two different, but identically priced goods, such as a mug and candy bar, are distributed equally between participants and they are given the opportunity to trade with one another. Given a trading volume of less than half the number of participants, it is inferred that they are unwilling to trade and are thus endowing their possessions with above-market prices. An expanded variation of this methodology is documented in a study by Kahneman et al. (1990), where participants are asked to specify a WTA (payment one is willing to accept for a good) for their object, and a WTP (payment one is willing to pay for a good) for the other. Results from this experiment show that a typical participant's WTA will be double that of their WTP, quantifying endowment as the magnitude of asymmetry between these two prices. Brasel and Gips (2014) describe WTA as one of two measurements of endowment, the other being its normalised ratio to WTP. Although their experiment is concerned more with the WTA/WTP ratio, their WTA measurements also prove to be reliable indicators of endowment.

Criticisms of the endowment effect have challenged issues regarding the methods through which it is evidenced, suggesting that WTA/WTP asymmetry is due more to participant misconceptions (eg. the understanding of the initial good as a gift that would be impolite to exchange) than loss aversion (Plott & Zeiler, 2007). This criticism remains controversial, as it is demonstrable that loss aversion persists even when the reference point is the decision maker's own expectations (Barberis, 2013). In addition, the endowment effect is prevalent in non-human interactions. Capuchin monkeys have

been observed to demonstrate endowment at a stronger margin that humans, indicating that endowment is the product of an evolutionary trait rather than a cultural disposition (Lakshminaryanan, Chen, & Santos, 2008).

An important distinction is that exchange goods (products owned for the purpose of reselling) are in general not susceptible to the endowment effect. The effect can be observed as an affirmation of loss aversion when such traders are operating in uncertain conditions (Dijk & Knippenberg, 1996). Market anomalies such as the endowment effect are not absolute and can be affected by the individual's trading experience, although the research is inconclusive in this regard. An individual's age, for example, does not seem to have a significant effect on the intensity of endowment (Harbaugh, Krause, & Vesterlund, 2001). Experienced traders of comparative goods do tend to think more rationally, reducing the magnitude of the endowment effect. In these cases, trading patterns resemble that of neoclassical economic theory much closer (List, 2004). The persistence of endowment even in these cases invites an alternative interpretation of the endowment effect; a form of risk aversion that is evident given certainty of the value of an object in one's possession (List, 2011). In this regard, endowment is considered as a manifestation of certainty bias, another idea introduced in prospect theory. This idea draws credibility from the observation that, in decisions involving uncertain outcomes, a person will disproportionately give preference to an option for which the outcome is certain even when the expected value is diminished (Tversky & Kahneman, 1986).

In terms of consumer product evaluation, the non-rational tendencies of actors become more apparent. One of the corroborated implications of the reference-dependent model advocated by prospect theory is the inherent power of product framing in the consumer evaluation of a product (Buda & Zhang, 2000). Presentation is thus critical in this process. An example of this is the influence of a product's packaging on its categorisation and evaluation (Van Rompay, Fransen, & Borgelink, 2013).

2.2.4 Digital value

Sensory input is important for consumers when evaluating product value. The influence of psychological distance, for example, can have significant influence on the perception

of a product's value (Bornemann & Homburg, 2011). In this case a product outside of an individual's direct experience is judged for its value using different criteria. Such a product in the context of high abstraction would be evaluated for its core benefits, while at lower levels of abstraction it would be judged in more pragmatic terms, such as the costs of purchasing and using it. The simple act of touching an item has also been known to elevate feelings of ownership, increasing endowment (Peck & Shu, 2009).

The endowment effect has received some attention in regards to digital products. In the context of online shopping, users who assume the role of highest bidder on an item experience a pseudo-endowment effect as if the user was already the owner (Wolf, Arkes, & Muhanna, 2005). In this case endowment can be considered responsible, if just partially, for the increased willingness to overbid the item's worth once the user has been outbid. In addition, longer periods of examination of the item in question correlated positively with bidding prices (Wolf, Arkes, & Muhanna, 2005). This is supported by the *mere exposure effect*, which contends that greater exposure to a particular stimulus tends to evoke a greater appreciation for it. Exposure is the degree to which the stimulus is accessible to an individual's perception, be it visual, auditory or otherwise (Zajonc, 1968).

The degree to which humans rely on their senses to judge the utility of products serves as an obstacle for digital retail, which has an inherent bias for high-abstract interaction. Nevertheless digital technology has demonstrated its capability to address this issue. Haptic imagery, inducing the imagined touching of an object, can create the perception of ownership as seen in the case of true physical contact (Peck et al., 2013). This imagery, when used to implicate the perception of physical control, can further intensify endowment and sustain more intense feelings of endowment the more vivid the haptic imagery. The use of touch screen devices in digital shopping echoes this finding, which has been also shown to elevate consumer perceptions of value toward a displayed product as opposed to when using a desktop computer or laptop (Brasel & Gips, 2014). The inference of these observations is that facilitating greater levels of interactivity with a digital object has the effect of shortening psychological distance to the user and thus inviting a more favourable evaluation of such an object.

Prospect theory has enjoyed extensive application in finance and insurance. It has also been applied with varying success in several non-economic fields, for example in gambling markets. However, there are areas of economics where prospect theory has yet to be considered extensively (Barberis, 2013). One field is digital retail. Some of the gaps in this field pertain to the understanding of prospect theory in a digital context, and how the endowment effect and indeed perceived value, is experienced when dealing with intangible digital constructs.

This is complicated by the prominence of digital objects intended to provide hedonic value, a form of value harder to quantify. Items sought for entertainment or lifestyle-enhancing qualities, such as songs, videos and video games, contribute significant traffic to the digital economy (Turel, Serenko, & Bontis, 2010). In this context, social value is less important whereas a sense of playfulness, referring to capacity for enjoyment and escapism, correlates stronger to overall value.

2.2.5 Experiential value

The privilege of ownership is not as prevalent as it once might have been, owing to the rise of digital distribution and the sharing economy (Belk, 2014). Embodied by the advent of *Web 2.0*, a shift in the design of information systems towards collaborative content creation, this *participatory culture* has been enabled by easily accessible information and media technology (Deodato, 2014). Participation and sociability are at the heart of this emergent paradigm, one in which computers have assumed a mediating role in human interpersonal relationships by way of social media (Rasanen, 2008).

The transforming perceptions of value in this space have significant economic implications. One prominent view is that the dominant materialistic culture is giving way to a *post-material* ethic manifested as a consequence of post-scarcity conditions in society (Inglehart, 1971). The emerging post-material *cyberspace* culture has been said to be an economy of ideas, language and social relationships, where the replicable and malleable nature of digital data undermines the need for industry and property (Barlow, 1996). Characteristics of the dominant consumerist culture, such as the virtues of

possession, exclusivity and hierarchy, are anticipated to be displaced by freedom of access, technological altruism, creative pursuit, and emphasis on one's mental capabilities as a judge of self-worth (Lehdonvirta, 2010).

Subsequent work has indicated that materialism persists in virtual spaces. People do in fact attach value to virtual goods as a form of meritocracy, such as, for example, currency in an online game obtained through skilful play (Evans, 2015). Virtual goods are consumed in the same way as material goods: as a form of establishing social status; fulfilling the expectations of one's peers; expressing one's identity; and to seek solutions to one's problems both real and imagined (Lehdonvirta, 2010).

Nevertheless the rise of the sharing economy coincides with a growing emphasis on experiences and memories as services, at the expense of material goods. This trend, dubbed as the *experience economy*, has implicated the transformation of brick and mortar retailers into a kind of *interactive theatre* (Mathwick et al., 2001). As articulated in Figure 2.2, the associated notion of *experiential value* can be considered in dimensions of extrinsic and intrinsic benefit, as well as active and reactive value (Mathwick et al., 2001).

Although both playfulness and aesthetics offer intrinsic value, their differentiating factor is the active role assumed by the customer. The transition from spectator to participant for a customer, corresponds with a shift in role from distanced appreciation to co-producer of value, transforming the exchange experience into active play (Mathwick et al., 2001). Extrinsic experiential value is a composite of consumer net return on investment and service excellence, a distinction comparable to that between quality/performance and price/value for money dimensions of perceived value (Sweeney & Soutar, 2001).

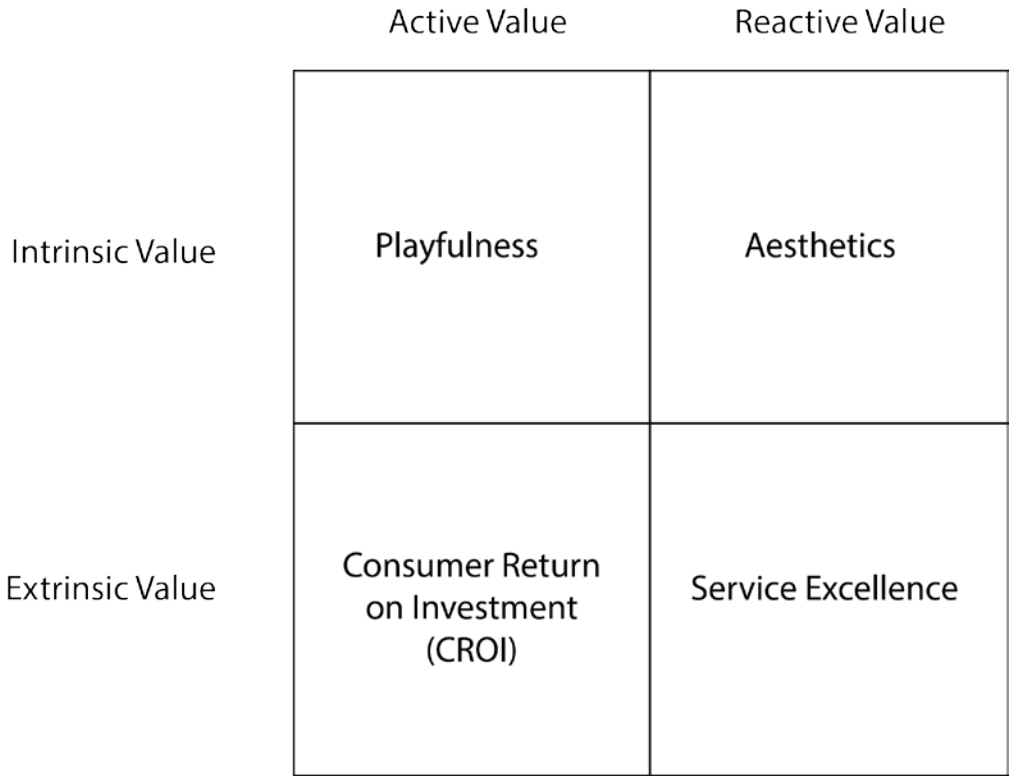

Figure 2.2: A typology of experiential value.
(Adapted from Mathwick, Malhotra & Rigdon , 2001, p.42).

In Figure 2.3, the composition of experiential value is illustrated as a hierarchy Aesthetic value is a combination of entertainment and visual appeal while playfulness incorporates escapism and enjoyment. Customer return on investment relates to the efficiency and economic value of the experience, while service excellence relates to its reactive efficiency (Mathwick et al., 2001).

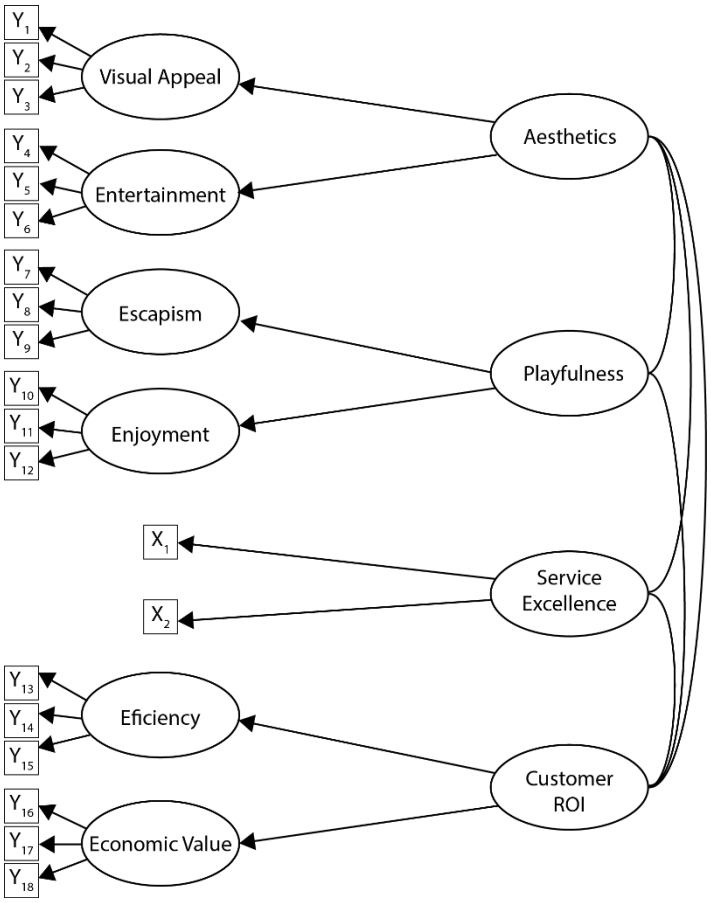

Figure 2.3: A hierarchical model of experiential value
(Adapted from Mathwick, Malhotra & Rigdon, 2001, p.43)

2.3 E-reading

The traditional understanding of text as written symbols and messages has been challenged and expanded by the use of digital devices for consuming content. Ereading, a term referring to the consumption of text from digital devices, has evolved in recent years to include multimodal discourse, such as images and audio. As a consequence, defining the *electronic book* has proved divisive. In practical terms, they are thought of as textual digital objects assuming the form of a book and intended to be displayed on a computer screen (Cox & Ormes, 2001). An e-book, however, is also considered an ambiguous umbrella term that encompasses several concepts and in many cases depends upon context (Manley & Holley, 2012). It is often invoked when referring to the three components required for accessing an e-book. Foremost of these is the *hardware* element, such as a desktop computer or a portable e-reading device. Second is the reader

software for interpreting and displaying the contents of a digital document. Such software may be included in the hardware or constitute as a separately downloadable application. The third element consists of the electronic document, often considered to be the e-book itself, a digital file containing text and other content (Cavanaugh, 2003). The e-book experience depends on a harmony between these three elements (MacWilliam, 2013). A more concise definition is that offered by Suarez (2010) of e-books as any book-length publication in a digital form.

Having spent several decades as the domain of academics and innovators, the e-book first emerged into the popular consciousness in 2007 on the back of *Amazon's* Kindle line of e-readers and was followed by *Apple*'s iPad in 2010 (McCraken, 2013). However, the practice of e-reading as a replacement for physical print media has faced greater resistance. Whether e-books can ever serve as a suitable replacement for physical books is uncertain, but perhaps irrelevant. As elucidated by Subba Rao (2001), "it is very clear that the e-book in one form or another is here to stay and it is relatively unimportant whether or not it eventually replaces the printed book" (p. 256). As the technical capabilities of mobile devices have expanded, it is unclear what role e-books will assume in the future of mobile media.

2.3.1 E-book Market

Optimistic spectators of the past have contended that e-books will one day supersede and replace the printed word (Lynch, 2001). Although by 2010 e-book demand had been seen as slow to match expectations congruent with technology hype, the upward trend of growth in the industry affirmed optimism regarding the future of e-books (Tian & Martin, 2011). As e-books have become less of a novelty and more mainstream, the growth in their demand has settled (Enis, 2014). Although having stopped short of replacing print books, the growth pattern is consistent with the final stage of Rogers' (1962) diffusion of innovations model, in which adoption plateaus and a new paradigm is established.

Having ascended into the mainstream, the market for e-books now transcends demographics. E-books for children, in particular, have experienced explosive growth.

Since delivering $470USD million in sales during 2012, corresponding with the proliferation of digital reading devices during this time, they have emerged as a significant market (Miller & Warschauer, 2013). More than this, e-books for children are a dominant force for technological development in e-books and the emergent e-reading culture, pushing the envelope of e-reading software and redefining the reading experience (Schreurs, 2013). This market for e-books has come to illustrate the most recent and emergent trends in e-books in general. This has been a somewhat contemporary phenomenon, as mobile technology has only recently progressed to the point of facilitating a reading experience capable of engaging children; an experience laden with visual content and opportunities for interactivity. The benefits of these features however, are disputable. For their multimedia capabilities, it is no surprise that tablet computers are the preferred platform for reading amongst children (Schreurs, 2013). Multimedia in this context helps alleviate monotony and boredom for younger readers, while interactivity enhances a material's likability (Wilson, Landoni & Gibb, 2002). Although engaging and entertaining to children, it is contentious whether or not the interactive elements of enhanced e-books are more distracting than beneficial to comprehension (Longa, Kessler, & Mich 2013). For this reason e-book design for child readers requires caution that incorporated features support and contribute to text rather than serve as a replacement (Colombo, Landoni, & Rubegni, 2014).

The types of interactivity facilitated by tablet computers such as games, music, video and audio have come to be familiar e-book features in this market. These developments contributed to a new understanding of what can constitute an e-book, accounting for the presence of multimedia objects and interactive tools that exceed the capabilities of dedicated e-readers (Seadle, Vassiliou, & Rowley, 2008). E-books of this nature are also known as *enhanced* e-books, characterised by divergence from the traditional presentation of a book that includes no more than text or illustrations (Schreurs, 2013). Enhanced e-books can facilitate interactive features and amongst these is user-centric customisation. Customisation in e-books is a contentious topic amongst e-book users and in general they are not willing to pay significant amounts of money for such customisation features. A certain minority of users however, are interested in such

features and are willing to pay up to 5% percent more for them (Bechter & Stommel, 2013).

In what can be considered a manifestation of convergence culture, dedicated e-readers, like the Kindle, have since experienced a continual drop in sales to the benefit of multifunctional mobile devices (MacWilliam, 2013). Tablet computers like *Apple's* iPad in particular have benefitted from this trend, incorporating the role of specialised devices like the Kindle. E-books are trending away from simple extensions of the book metaphor towards interactive applications in their own right.

2.3.2 E-publishing

After spending an extended period in the early adoption phase, the mainstream emergence of digital reading now represents real financial challenges and commercial opportunities to the book publishing industry. Publishers have been open to experimentation with digital models and implementing organisational change. However, this approach has been tempered with trepidation. Publishers have been by and large anchored to existing business models and traditional distribution systems. Digital initiatives have tended to be limited and fragmented, demonstrating that the industry's response to digitisation has been reactive rather than proactive (Øiestad & Bugge, 2014).

A symptom of this disconnect is the manner by which publishers have sought to raise the price of e-books to parity with physical editions, epitomised by the campaign to establish an agency-based e-book publishing agreement. In such a system, publishers are allowed to set prices while intermediary retailers such as *Amazon* and *Apple* would take a certain fee from each sale. In 2012, *Apple* and a group of major publishers were sued by the United States Department of Justice for conspiring to raise e-book prices by use of this model (Gaudin & White, 2014).

Business models and sales structures inherited from analogue book publishing can be viewed as standing in the way of realising the potential of digital technologies (Øiestad & Bugge, 2014). Lack of standardisation in e-book design and sales channels has

fostered a sense of uncertainty among book publishers regarding long term digital strategies. This is in part due to the diverging goals of publishers and the diverging digital formats for delivering e-books (Øiestad & Bugge, 2014).

Navigation of intellectual property rights has also proved challenging for publishers in developing digital strategies. While digital goods have inherent benefits that are attractive to publishers, such as the ease of replication and speed of delivery, these benefits have proved just as advantageous for the cause of digital piracy. Piracy, as in a variety of other industries, has the effect of undermining demand and the capacity to profit from content. Attempts to thwart the threat of piracy by use of DRM (digital rights management) systems have had mixed effects, and in some cases exacerbated the problem (Oestreicher-Singer & Sundararajan, 2004).

2.3.3 Resistance

Having failed to meet expectations in terms of demand, the state of e-books today is defined by resistance. This resistance can be typified in two forms, the first of which pertains to the preservation and familiarity of books as a cultural institution. The other, but perhaps more significant form, pertains to the reading experience of physical books compared to e-books. There is reason to believe that both factors have been disadvantageous to the e-book industry (Staiger, 2014).

Cultural resistance

One of the most recognised challenges to the growth of e-books is the prevalent cultural affinity for print books (Stone, 2008). Much of the progression in e-reading technology has been intended to match the presentation and affordances of print books, invoking what is known as the *paper book metaphor*. Much like how interface designers of personal computers fabricated the desktop metaphor to create a virtual environment that was familiar for its users, the paper book metaphor invites consideration of e-book interfaces in terms of print books. An e-book extending the book metaphor is intended to be thought of as a physical book embedded in an electronic device, in so doing invoking all the physical properties of a print book (Yang, 2015). Coupled with this, e-books aim to match the affordances of print books.

The term affordance refers to the performable actions applicable upon an object as derived and perceived from its forms and shapes (Gibson, 1977). Much like as how any object with a handle affords the action of grasping, a print book is holdable, openable, flipable, turnable and writable, among other affordances, and each of them contribute to the reading experience (Yang, 2015). The affordances of digitisation have ensured that e-book readers have conflicting expectations regarding e-books, as opposed to their printed counterparts. Whereas such physical books are expected to be revised and reprinted over time, e-books, like other digital products, are expected to be updated and patched constantly with allowances for customisation (Øiestad & Bugge, 2014).

E-books, as digital artefacts, are not owned in the same sense that one would own a physical book. Terms of service agreements dictate that users are only granted the right to store and make use of content obtained in digital form. This differs from physical retail where although the consumer is subject to some restrictions of intellectual property, the consumer is granted the legal right of ownership. Readers of physical books would be more accustomed to greater flexibility of usage rights, given books that can be loaned, borrowed, resold and shared (Stone, 2008).

The notion of ownership itself is undermined by the affordances of digitisation, and as a result, users of digital systems are conditioned to think of digital objects as information rather than as possessions. As noted by Raban and Rafaeli (2006) however, information is a market good, although a unique one. Information is expensive to produce and cheap to reproduce, and the usage and access rights of information are copied rather than traded or transferred. Measuring subjective value of an e-book has inherent obstacles due to its digital makeup. However, Raban and Rafaeli's study demonstrates an effective example for commodifying information and measuring its subjective value. Their study employed the business simulation computer game, *Lemonade Stand*, as an ecosystem in which players were encouraged to trade information for achieving the highest score. Offering the opportunity for players to buy or sell such information, the dependent variables were recorded for each bid and used to gauge the endowment effect.

Experiential resistance

Many of the technological capabilities of modern mobile devices that elude print media give certain pragmatic advantages to e-books. Hyperlinking in digital text for example, can enhance or extend a reader's experience by facilitating access to supplementary information and media (Stone, 2008). However, the *resistance* to e-books is beyond cultural. A recurring distinction observed by researchers in this field is the cognitive process by which e-books engage readers compared with print books (Todhunter & de Byl, 2015).

Research suggests there is no imminent concern for an e-book takeover, although there is reason to believe the innovation diffusion rate of e-book adoption has yet to peak (Zhang & Kudva, 2014). Moreover, the general traits of e-book readers are unsurprising; young, highly educated, digitally literate internet users, and their reasons for situational preference of e-books are utilitarian in nature (Bergström & Höglund, 2014; Zhang & Kudva, 2014; Jung et al., 2012). Such readers prefer e-books for a multitude of practical reasons, such as ease of transportation, price, and purchasing convenience, although they are considered not as easy to read (Chao, Fuxman, & Elifoglu 2013). This correlates with the mentally taxing experience of reading from an electronic screen (Wästlund, Reinikka, Norlander, & Archer, 2005). Although earlier studies have suggested that reading text from a display is slower than from a printed page (Creed, Dennis, & Newstead, 1987; Gould, Alfaro, & Barnes, 1987; Gould & Grischkowsky, 1984; Heppner, Anderson, Farstrup, & Weiderman, 1985; Kruk & Muter, 1984; Muter, Latrémouille, Treurniet, & Beam, 1982), more recent work has been less clear on the matter (Noyes & Garland, 2008). As the quality of digital displays has evolved, however, many studies conclude that reading from digital text results in shallower comprehension (Jeong, 2012; Coiro & Dobler, 2007; DeStefano & LeFevre, 2007; Eshet-Alkali & Amichai-Hamburger, 2004; Eveland & Dunwoody, 2002). The degree to which this is evident, however, is inconclusive (Dimaano, 2015).

2.3.4 Strain

E-books are read slower and produce greater mental strain than print books, although the reason for this is unclear (Wästlund et al., 2005). Closer parity to print books in this regard can be achieved when matching the visual characteristics of a printed page, in terms of typeface and display resolution more closely (Noyes & Garland, 2003). An early criticism of e-readers was an inferior display compared to a printed page (Stone, 2008). Backlit e-readers, like many electronic mobile devices, have documented detrimental effects on human health due to the inherent visual strain. Such devices can induce sleeping disorders by delaying the circadian clock, suppressing production of the hormone melatonin, shortening the count and time of REM sleep periods, prolonging the time taken to fall asleep, and inhibiting alertness the following morning (Chang, Aeschbach, Duffy, & Czeisler, 2014).

Since the *Sony* Reader, it has been common in e-readers to implement *e-ink* technology as a non-emissive, paper-like alternative to LCD screens intended to mimic the presentation of a print book. These interfaces are notable in that they alleviate the strain of e-book reading (Siegenthaler, Wurtz, Bergamin, & Groner 2011). Although e-ink tends to inhibit the user interface and multimedia versatility of e-readers, and although some users in fact prefer the glossy LED-backlit displays of *Apple's* iPad, e-ink allows for longer periods of reading without users experiencing fatigue (Huthwaite, Cleary, Sinnamon, Sondergeld, & McClintock, 2011).

2.3.5 Navigation

A noted significant factor regarding the discrepancy between print book and e-book comprehension is the speed and efficiency of navigation by the reader. Navigation features are often desirable in e-books, such as the ability to quickly skim the contents of an e-book usually embodied by a hyperlinked table of contents. Navigation icons, search tools and bookmark utilities are also considered important (Malama, Landoni, & Wilson, 2005). However, the role of *spatial memory* in the navigation of print books is significant, as is its absence in a digital environment (MacFadyen 2011). Spatial memory is a cognitive ability of humans critical for remembering information about physical locations. Recollection of physical spatial memory is more efficient than with

general abstracted information, which takes time and effort to manipulate and process (Jones & Dumais, 1986). Graphical user interface design has taken advantage of this ability in the past with much success, in particular with regards to computer desktops. Physical books are similar, in that progress and location is spatially evident in a sequential order. This fixed layout is the trigger for spatial memory, facilitating effective and intuitive data retrieval (Yang, 2015). Identification of the subsequent cognitive load inherent in navigating digital documents has prompted an emphasis on *lightweight* navigation design, intended to minimise the consciousness of document navigation. When implemented correctly such a design can increase usability and user satisfaction (Pearson, 2010).

2.3.6 Lack of preferences

One notable observation from the current literature on e-book preferences is the lack of significant correlation between age or generation and e-book inclinations, and in this regard, there appears to be no conclusive evidence to differentiate between fictional and non-fictional content. Although some earlier studies have indicated that children have greater comprehension with e-books than printed books (Greenlee-Moore, & Smith, 1996), more recent research indicates the opposite (Jeong, 2012). Despite the popularity of mobile devices today, the perception of e-books as suitable replacements for print books has been at the very least premature when it comes to integration of e-readers in schools. Although many students have access to devices capable of e-reading, they are not regular consumers of e-books and are not in fact all that attracted to e-readers as an instrument for accessing e-books (Merga, 2014). Despite being their largest demographic today, younger users have been shown to have mixed feelings towards e-books, preferring print for elusive, hedonistic reasons while acknowledging the potent pragmatic benefits of digital text (Gregory, 2008). Research on undergraduate samples suggests print books represent the preferred method of book consumption (Walton, 2014; Foasberg, 2011; Woody et al., 2010; Ismail & Zainab, 2005). Print books are preferred by a margin of as much as three to one, and any intention to use an e-reader hinges on extrinsic motivators, such as perceived playfulness (Torres, Johnson & Imhonde, 2014). In terms of experiential value as discussed in Section 2.2.5, facilitating playfulness as an intrinsic active value is a critical element of the print book/e-book

comparison. E-books pale in comparison to print books in regards to a sense of control, lacking the "serendipitous freedom" (Brown, 2001, p. 393) afforded by physical pages. Another issue of control is an inability to loan titles in one's collection, owing to the concept of books that are licensed rather than owned (Richardson Jr, Mahmood 2012). E-book providers offering solutions to these issues include *Amazon*, having launched a regulated e-book lending service some years ago in spite of publisher concerns regarding unprofitability (Trachtenberg, Woo 2011).

Any considerations for effective e-book design must contend with the medium's perceived deficiencies when compared to print books. The literature demonstrates that readers prefer print books for their extrinsic attributes, and so compensating for these attributes should be considered the prerogative of e-book designers.

2.4 Tangibility

Whereas print books are bound to the phenomenological world, a digital e-book file can transcend the limitations of physical space. They can be compressed into miniscule volumes and can be replicated with perfect accuracy infinite times. Using computer networks, they can be transferred through space with speed and ease. The result is that e-books are more convenient and practical for readers in many regards (Chao, Fuxman, & Elifoglu 2013). One persistant distinguishing factor that embellishes prints books against e-books, however, has been articulated as a vague notion of tangibility or *thingness* (Staiger, 2014). It is understood that e-books are lacking in a sense of tangibility owing to a more limited engagement with human senses than print. Compared to its digital counterpart, the traditional print book is characterised as a multisensory experience (Mangen, 2008). A book's smell, for instance, is one such aesthetic characteristic that has only come to be identified as significant to the reading experience since the emergence of digital texts (MacFadyen, 2011). A book's aesthetic qualities are a product of more than just its literary form, and a reader's expressed preference for such sensations as the feel of paper against their fingertips represent an aesthetic argument for how texts are meant to be read and experienced (Jung, 2012). The elements of a physical book create an impression that transcends the words printed

on the page. Touching and holding enforce an innate sense of presence that can render electronic media as *soulless* by comparison (Young, 2001).

Although the sensation of tangibility is difficult to quantify, the technique of establishing it in a digital environment is a matter of manipulating human senses. Perception of one's environment is itself a composite of sensory input (Marc & Ernst, 2004). The practice of altering this perception based on deceptive sensory stimulus is referred to as an illusion, and can be implemented in interactive applications by way of feedback. In HCI, feedback has been referred to as the information sent to a user in response to the user's input (Renaud & Cooper, 2000). Feedback has been utilised in user experience design to satisfy communication expectations that carry over from human-human interaction. In much the same way that a person might, during a conversation, anticipate a nod of the head as confirmation of understanding, a response from a computer upon receiving a command serves to alleviate the uncomfortable ambiguity as to whether the command has been received. This sensation is known as psychological closure (Perez-Quinones & Sibert, 1996) To this end, Spink (1997) summarises visual, auditory, and tactile communication as three notable forms of feedback. It is through leveraging these sensory channels that human perception can be augmented and tangibility can be induced.

2.4.1 Playfulness

The notion of playfulness itself is thought of as a broad scope of experiences that are considered joyful or pleasurable in nature, exaggerated from a purely functional purpose. Central to this enjoyment is a sense of control and empowerment, as well as meaningful sensory feedback (Korhonen, Montola & Arrasvuori, 2009). Playfulness would seem to align with the elusive concept of tangibility, both of which draw potency from the sensation of control and both of which have been referred to in the literature as having a positive effect on perceived value (Sections 2.2.4 and 2.2.5).

Central to playfulness, however, is the act of play and sense of fun, concepts that, while themselves have eluded concrete definition, have received considerable attention in the area of game design studies (Fullerton, Swain, & Hoffman, 2004). Play is most often

thought of as any *not-serious* activity, one that stands apart from *ordinary* life and, while absorbing a player's focus, is engaged with for no particular material interest (Huizinga, 1950). Activities of play are by nature separate from the ordinary world, as circumscribed within the limits of space and time (Caillois, 2006). Necessary to play is the persistence of uncertainty and unpredictability as well as an impetus to respond to obstacles within the context of the rules provided. A known outcome with no possibility for error or surprise is incompatible with the nature of play (Caillois, 2006).

Playfulness, by extension, has been viewed as both a trait and a state of mind relating to the state of play (Webster & Martocchio, 1992). As a trait, playfulness exists in any activity that is participated in by choice (Mathwick et al., 2001). Considered as a state of mind, however, it follows that other tasks outside games can benefit from playfulness in design to alleviate difficulty or mundaneness (Fullerton et al., 2004). Compared with notions of productivity, as elucidated by Berger, Callois, and Barash (1963),"play is an occasion of pure waste: waste of time, energy, ingenuity, skill and often of money".

Playfulness in user experiences refers to elements that engage the attention of a user by way of creative enjoyment. Such an experience is one in which a user leverages existing elements to create something new, and in the process, develop skills through exploratory behaviour. User interfaces that are described as playful and enjoyable to use tend to be more than purely functional. A playful interface might contain elements of role-playing, active work with imagination, experimentation or contextual metaphors (Kuts, 2009).

An individual's playfulness with computers tends to correlate to their self-rated computer competence (Webster & Martocchio, 1992). Although playfulness has a positive effect on the subjective experience of the user, in user interfaces it can often make a task longer to complete. Users can become distracted by play and it can be unproductive in systems where time is of the essence (Hoffmann & Novak, 1996).

2.4.2 Tactility

The *indeterminate distance* from which digital texts are engaged, contrasts with the sense of being phenomenologically in contact with the text itself, often evocative of dexterity in their navigation by way of hands and fingers (Mangen, 2008). The resulting disconnect is referred to as *haptic dissonance*, characterised by an "irritating internal dissonance" that arises from inconsistency between cognition and haptic perception (Gerlach & Buxmann, 2011, p.2). Haptic dissonance can arise in any circumstance when a person touches an object that conflicts with their expection of how that object is supposed to feel. Dissonance in this sense refers to the theory of *cognitive dissonance*, describing a human compulsion to seek consistency between cognitions (Festinger 1962).

Tactile feedback is an effective mediator in the understanding of one's environment. In the operation of robotic surgical systems, for example, surgeons find that the presence of haptic feedback bolsters their awareness regarding their instruments (Koehn & Kuchenbecker, 2014). Studies in consumer science show that touching a product in a retail environment has the effect of elevated purchase intentions even when the act of physical contact provides no substantial information about the product itself (Peck & Childers, 2003; Peck & Wiggins, 2006). In addition, mere touch has a potent effect in establishing a heightened perception of ownership even in the absence of legal ownership. This impression results in a positive and significant effect on the valuation of that item (Peck & Shu, 2009). However, the influence of haptic perception is not universal. The Need For Touch scale is a metric proposed by Peck & Childers (2003) to analyse the varying influence of haptic information to different people. The development of the NFT scale follows that the psychological effects of haptic interaction vary between people. A person who scores highly in this metric would prove to be more receptive to haptic information. For example, while shopping for clothes such an individual may be more likely to take an interest in an article's tactile traits such as its *softness*

Sensory stimuli in general tends to provoke heightened instinctive, subconscious responses when compared to learned information such as recalling a brand name

(Balaji, Raghavan & Jha, 2011). Touch is unique in this regard as a sense characterised by its proximal nature, being the only sense experienced by way of contact with the skin (Krishna, 2010).

Investigations regarding the influence of touch on e-book reading have been limited, tending to focus on touch screen applications. However, tactile feedback does in fact correspond with a more pleasant user experience (Koskinen et al., 2008). In the absence of physical buttons, various mobile device manufacturers compensate through incorporation of vibration motors that respond to user input, and this has shown to achieve near parity with the user experience of physical buttons.

2.4.3 Audio

Despite serving as a significant role in the human-computer relationship, the importance of mediated sound to virtual environments has been somewhat undervalued (Kramer 1995). The potential role of audio in the e-reading experience has received scarce attention. Much of the interest is in regards to the incorporation of dramatic soundtracks into e-books, although studies investigating this potential have yielded mixed results. Such soundtracks tend to be more distracting than immersive when applied unilaterally (Holenderski & Hu, 2011). Nevertheless, ambient and interactive sound effects can correlate to an enriched user experience (Back, Cohen, & Gold, 2001). Much of sound's immersive power, however, is its capacity to influence complementary human senses (Krishna, 2012). As humans perceive phenomena by combination of sensory input, all perception is by virtue, multisensory. The process by which these senses are aggregated into a single stimulus, thus enhancing one's perceptual reliability and saliency regarding the stimulus, is referred to as *intersensory synchrony* (Vroomern & Keetels, 2010). This concept is central to understanding the ability of a single sensory stimulation to transform one's perception when synchronised.

One notable experiment in this field is the *hearing lips and seeing voices* illusion of McGurk and MacDonald (1976). In this experiment, a subject is exposed to a sound with a recognisable visual component (such as the mouth movements associated with distinct phonetic sounds). When substituted with the distinct visual component of a

second recognisable sound, this results in the listener instead perceiving a third sound (McGurk & Macdonald, 1976). The resulting *McGurk effect* has been recognised as a compelling indictment of human senses to bias each other with perceived synchronicity. Tactile input, however, when paired with auditory stimulation, can produce a more vivid sense of synchronicity than any other combination of senses. In empirical terms, the perceived synchronicity of audio-tactile sensory input has a temporal resolution exceeding that of audio-visual or visual-tactile sensations (Fujisaki & Nishida, 2009).

Research of *audio tactile* interface design concludes that the combination of auditory and tactile feedback induces a heightened sense of synergy and a richer, more satisfying user experience (Altinsoy & Merchel, 2009; Chang & O'Sullivan, 2005). The use of audio feedback has also been employed to compensate for a lack of haptic feedback in user interface design for touch screens. When synchronised auditory feedback accompanies touch screen typing, user-typing speed can be improved with no increase in error rates (Schuck, 1994).

In the absence of physical buttons, mobile device manufacturers have compensated through incorporation of vibration motors that respond to user input, and this has shown to achieve near parity with the user experience of physical buttons. Such feedback patterns are preferred based on their ability to replicate the tactile sensations of analogue input. For example, a succinct pulse of vibration motors is reminiscent of typing upon a physical keyboard, while a sustained buzz might invoke a more alarming response (Shin, Lim, Lee, Lee, & Kyung, 2014).

One example of this capacity lies in the *parchment-skin illusion,* a demonstration of the capacity of audio feedback to influence haptic perception. In this instance, the effect is observed when a sound wave synchronises with a subject rubbing their palms together in a back and forth motion. With a high frequency tone, the subject will report that that their skin assumes sandpaper-like qualities (Jousmäki & Hari, 1998). Sound frequencies have been found to induce a variety of tactile sensations when coupled with touch in such a manner. For example, sound waves in the range of 30Hz and 300Hz elicit feelings of ruggedness while waves from 30Hz to 600Hz induce that of roughness (Kim,

Kyung & Kwon, 2007). Perception of a physical object's stiffness can also be manipulated by pairing sounds associated with a harder surface upon tapping (DiFranco, Beauregard & Srinivasan, 1997).

2.5 Gap in the Domain Knowledge

Reviewing the literature on this subject yields a significant gap in the existing research pertaining to the use of the audio illusions to induce heightened haptic interactions with e-books or a wider scope of digital products. To address this gap in understanding and contribute to knowledge in the field, the study will investigate sound feedback mechanisms in e-books and their impact on the endowment effect, thus determining whether haptics can increase perceived value of digital artefacts.

2.6 Summary

Throughout the literature review there is a consistent recurring theme of extrinsic and intrinsic value. Intrinsic value represents a rational assessment of utility, while extrinsic is emotional and hedonic. Extrinsic sense of value is influenced to a significant degree by sensory input, through which we perceive aesthetic quality. Phenomenological contact is the reason that touching a product in a retail context elevates one's perceived ownership and, by extension, the inability to touch an e-book is detrimental to perceived value, regardless of any intrinsic benefit. However, by use of synchronised interactive feedback, experiments have shown a capacity to induce false sensory experiences, and this has yet to be applied in compensating for haptic dissonance in e-books.

3. Methodology

3.1 Introduction

The purpose of this study is to determine the effect of interactive audio feedback on the perceived ownership of e-books. It is hypothesised that audio feedback, in facilitating a greater sense of tangibility, will intensify a user's sense of perceived ownership when interacting with an e-book. This would be reflected in the extent of the endowment effect, an elevated sense of perceived value that correlates with ownership, as discussed in Section 2.2.3.

For this study, an interactive web application, *Bookseller* (the source code of which can be accessed here: https://github.com/StewTodhunter/Bookseller), was designed and developed to facilitate interactive audio feedback within e-books, and collect quantitative data regarding a user's perceived value of the audio feedback. Designed around an e-reader interface, the intention of *Bookseller* was to present e-books in the manner of the print book metaphor, augmented by audio feedback, in such a way that would impose a sense of exclusivity. The aims of this application are embodied by the following research questions:

- To what extent does audio feedback impact perceived ownership of an e-book?
- To what extent does interactivity impact perceived ownership of an e-book?
- To what extent does audio feedback impact interactivity with an e-book?

For the purposes of addressing these questions, *Bookseller* was designed to expose a reader to an e-book with interactive audio feedback and then measure the user's perceived value of that e-book. A range of different sounds with distinct waveforms were employed, to test the validity of the hypothesis.

3.2 Research Design

This study will adopt the endowment effect hypothesis as a framework for quantifying subjective value of e-books. First proposed by Thaler (1980), the endowment effect measures the perceived ownership felt by an individual towards a possession. It's

quantified as the difference between that individual's specified WTA (willingness to accept payment) and WTP (willingness to pay) in currency. Where the endowment effect is prevalent, WTA would exceed WTP. As applied to this study, it is hypothesised that the independent variable, a particular sound effect synchronised with interaction on a touch screen device, would result in a higher WTA, the dependent variable. This is because the endowment effect can be magnified by the sensation of touch, real or imagined (Peck et al., 2013). Given the illusory capabilities of synchronised feedback sound (Jousmäki & Hari, 1998), a sound effect synchronised with touch screen interaction should be sufficient to induce a sense of tangibility, hence elevating perceived value. The resulting data would be analysed using a one-tailed ANOVA in SPSS v22 for the PC to determine the mean WTA for each sound.

3.3 Setting and participants

Owing to the transcendent electronic nature of the study, the setting of the experiment is a virtual space with no geological association. Participants recruited locally at the Bond University campus comprised 15% of the sample. Fliers advertising the study were disseminated in classes and posted on public bulletin boards. Other participants, the remaining 85%, were recruited online by way of leveraging social media networks and their respective advertising services. These participants represented a diverse range of nationalities and geological locations. Across both recruitment channels, participation resembled a convenience sample. All participation was incentivised with a prize draw for a $100 gift voucher valid at *Amazon*, *iTunes* or *Google Play*. All participants were required to engage with the instrument by use of mobile touch screen devices limited to the Android and IOS operating systems. These ranged from smartphones to tablet computers.

Several factors were accounted for in deciding an appropriate number of participants that would yield a statistically significant sample for a single-tailed ANOVA test. A priori analysis was utilised to calculate an appropriate sample size, in which sample size (*N*) would be a function of power level, significance level (*p*), and population effect size. By use of the G*Power 3 software, 305 was deduced to be the optimal number of participants required for a statistically significant sample.

3.4 Instrumentation

Data were collected by way of the browser-based application *Bookseller* which was designed around a rudimentary e-book reader interface. A full walkthrough of the application can be found in the Appendix. The e-book, *Summer Days* by George M Baker, was chosen at random from the Project Gutenberg e-book repository, obtained as a plain text file. This book was chosen for little more than it's obscurity, minimising the chance that pre-existing personal attachment could bias valuation. Each user was presented with two modes: a three-dimensional representation intended to resemble a hardcover print book with appropriate cover decoration (the exterior); and a layout of the first 10 pages of content (the interior). Both modes supported touch screen user interaction. While in the exterior mode (shown in Figure 4.2), a user could manipulate the book's rotation by dragging their finger. In the interior mode, a user could flip through pages in an animated manner typical of many e-reader applications. These two modes represent two kinds of interaction worth considering in the hypothesis: the exterior mode shown in Figure 3.1 is superfluous interaction, or interaction that does not offer the user any new information about the e-book, and is performed for its own sake. The interior mode shown in Figure 3.2 is functional interaction, or interaction that is performed for the purposes of parsing the e-book content. A third mode was accessed for the purpose of *selling* the e-book, presenting a user with a slider element for indicating a suitable price, and a *sell* button for confirmation. This is shown in Figure 3.3. By use of an interface on the left hand side of the screen, a user could switch between the exterior, interior, and selling modes at will.

Figure 3.1: Exterior mode in Bookseller

Figure 3.2: Interior mode in Bookseller

Figure 3.3: Selling mode in Bookseller

The independent variable in this research was the sound emitted to correspond with the user physically interacting with the e-book by touch input. This sound was randomised for each user to ensure unbiased and comparable measurement. At the initialisation of the application, one of five options for audio feedback was randomly assigned to the user. These options included four distinct sounds: a low frequency tone; a high frequency tone; a low frequency noise profile; and a high frequency noise profile. The fifth option was silence. The selection represented two dimensions of sound: frequency and spectrum width. These dimensions were decided on for different reasons. Sound frequency was chosen as the first of these dimension due to it being a pertinent factor for influencing haptic perception, as evidenced in the parchment-skin illusion (discussed in Section 2.4.3). In the parchment-skin experiment, a high frequency feedback tone, when synchronised with haptic interaction, caused participants to perceive their skin as assuming of paper-like qualities (Jousmäki & Hari, 1998). For this reason, a high pitched tone was the first of these sounds selected for the *Bookseller* instrument. An optimal frequency, one that was within the range capable of being produced by most

modern mobile speakers, was decided to be 640hz. The second of these sound options, was a low frequency tone of 200hz, representing the other end of the scale.

Spectral width, the second dimension of sound, refers to the range of audio frequencies present in a certain waveform. Whereas a sound with a focussed spectral width, consisting of a single frequency, is more recognisable as electronically produced, sounds with high spectral width, comprised of a larger variety of frequencies, are more common in nature such as in the ambient sound of the wind (Lewicki, 2002). For the purposes of this experiment, noise profiles were generated to represent high spectral widths. Such audio signals are notable for their resemblance to the actual sound of skin on paper. A higher spectral width can be considered indicative of a more *realistic* sound.

The third and fourth sounds resided at the opposite of end of the spectral width scale to the *narrower* tones of the first and second. These noise signals, in accordance with the first dimension, frequency, were differentiated in regards to frequencies emphasised. As noise profiles are categorised using colour labels, describing a power bias towards certain frequencies, the third sound, a *pink* noise profile, emphasised higher frequencies while the fourth, a *blue* noise profile, emphasised lower frequencies. The two dimensions are illustrated in Figure 3.4.

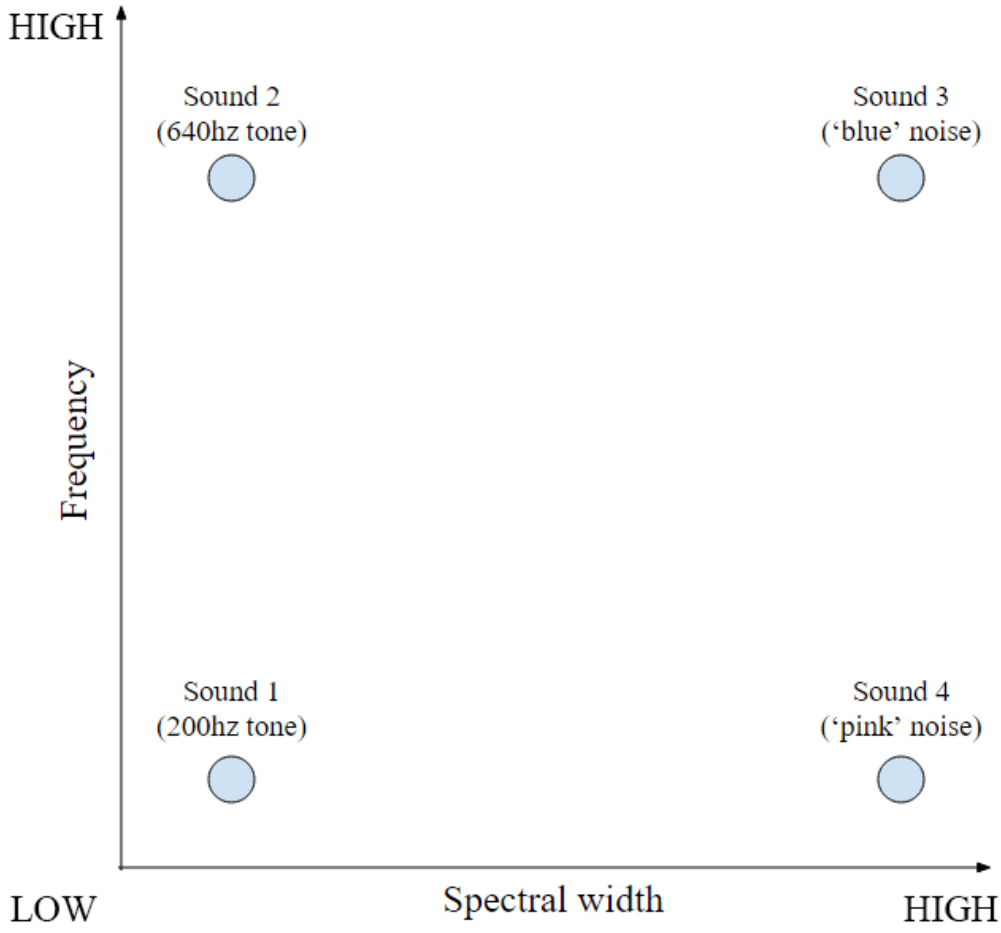

Figure 3.4: The dimensions of sound employed in the study

A participant's specified WTA (willingness to accept) payment for a good value served as the dependent variable. This value, measured in dollars, was interpreted as an indicator regarding the intensity of the endowment effect experienced for each participant. All other factors in the user experience, such as the title and content of the book as well as the visual presentation, were control variables.

Depending on a participant's randomly assigned sound, *touching* the e-book in either exterior or interior mode corresponded with synchronised audio feedback. Users were prompted to set a selling price for the e-book, having been given ample opportunity to interact with it. In what could be seen as a deviation from previous studies regarding the

endowment effect, in which endowment is measured as a ratio of WTA to WTP (willingness to pay) for a good, *Bookseller* was designed to measure only the WTA.

3.5 Procedure

The procedure for the study was intended to be fast and straightforward for participants. Any participant accessing the *Bookseller* instrument's web page was immediately presented with an introductory message (see Figure 3.5), informing them about the nature of the research. Specific details, in regards to the role of sound in the experiment, were omitted for the sake of eliminating bias. Once confirming their intention to participate in the study, as well as indicating they are of acceptable age, participants were given a make believe back story. The supplied pretence made reference to a tablet computer that was a gift from an aunt. The tablet contained a single e-book, *Summer Days*, that was to be sold off for a price set by the participant. Upon acknowledging this information, a participant would proceed to the e-book interface itself.

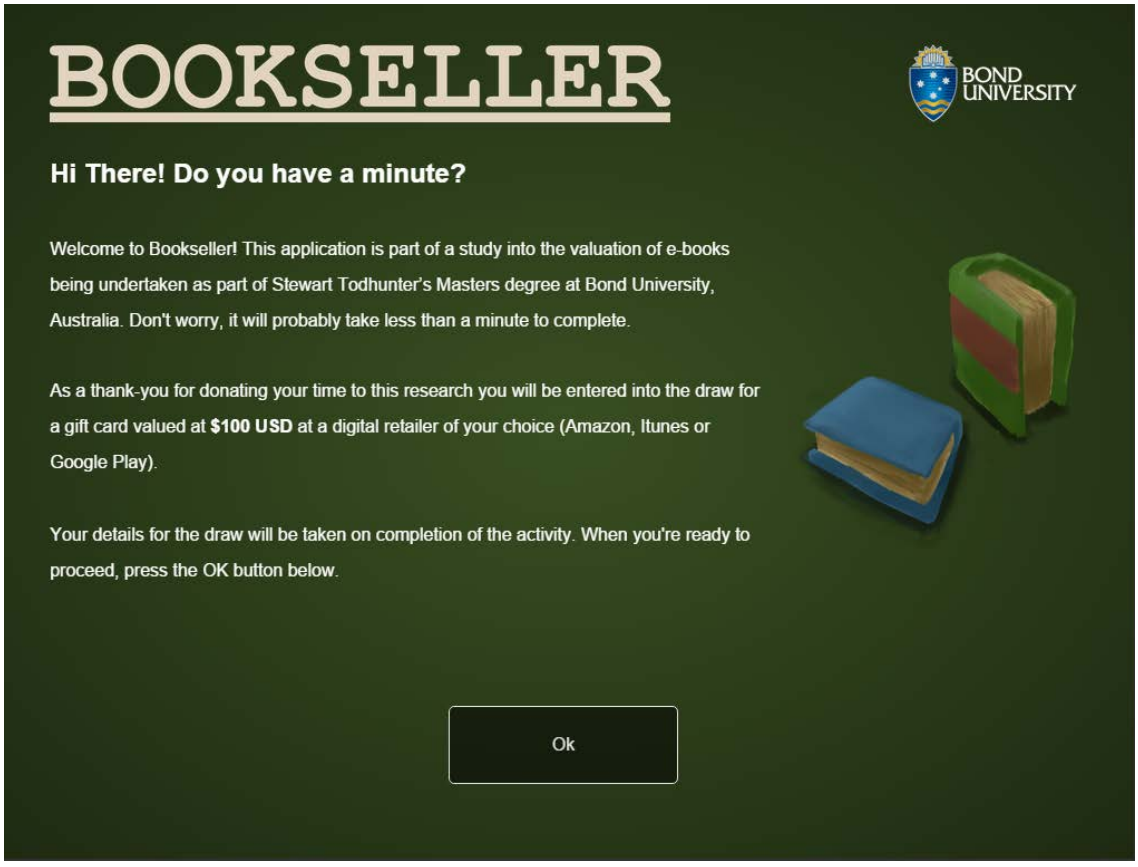

Figure 3.5: The introductory message of Bookseller

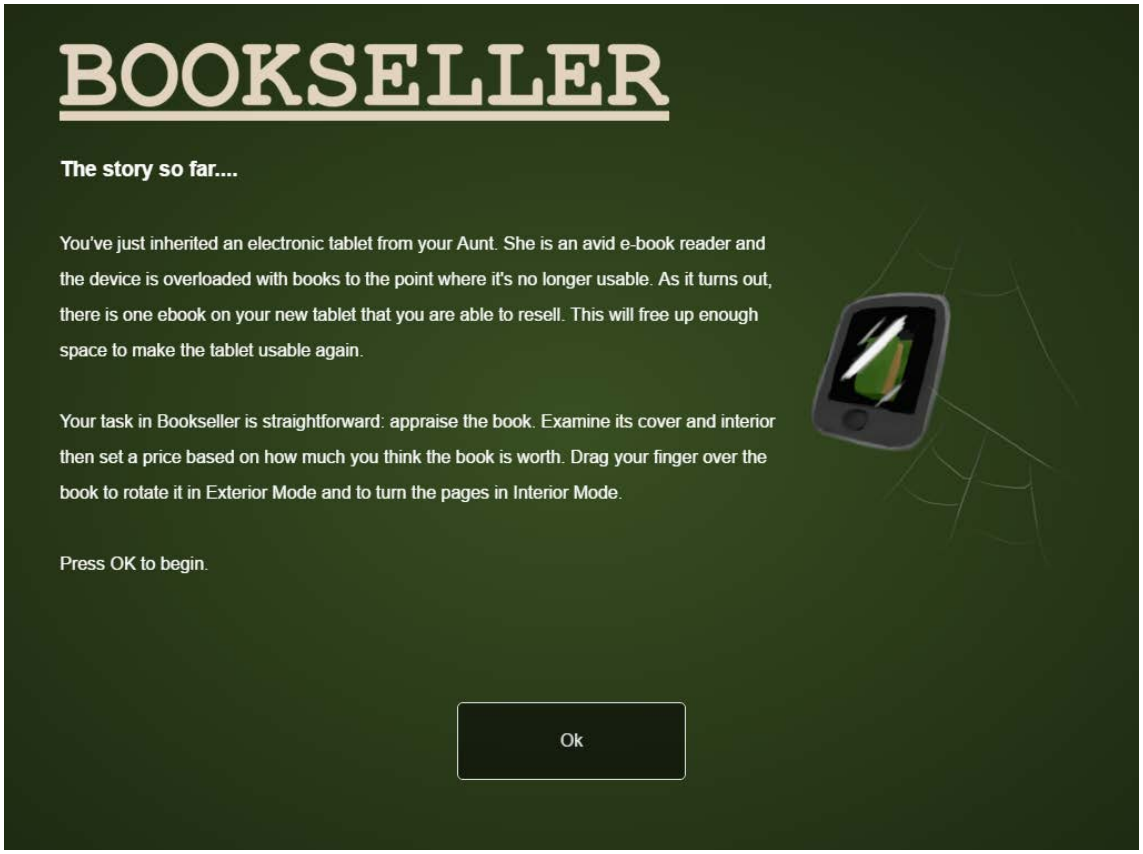

Figure 3.6: The pretence script of Bookseller

Participants were exposed first to the exterior mode of the interface. User analytics were recorded for each participant regarding the amount of times the e-book was touched, the cumulative time for which it was touched, and the amount of time for which the interior mode was activated, inferring the amount of time for which it was read. Once satisfied, participants would switch to the selling mode of the interface, indicate their preferred selling price, and press the corresponding *sell* button. This concluded the experiment.

3.6 Data processing and analysis

Data collected from the instrument was stored on an SQL server for the duration of the study so it could be exported and organised for later analysis. The data was spread across two tables pertaining to user records and the *sales* by each participant. Each participant was assigned a UUID (universally unique identifier) to act as a key between the two tables. This identification consisted of a 32 character string of random letters

and numbers, intended so no two participants would be assigned the same UUID. The records of particular interest were the independent and dependent variables for each participant, consisting of the sound effect index (numbered 0 to 4), and the specified WTA value respectively. This represented five treatments: a high frequency tone feedback; a low frequency tone feedback; a high frequency noise profile feedback; a low frequency noise profile feedback; and no feedback. The group without any feedback sound applied were to be considered the control group. The dependent variable, WTA, was used to gauge the intensity of endowment for each participant. Auxiliary data consisted of each participant's user analytics: device and platform information; time spent browsing the interior mode in milliseconds, the amount of touch interactions on the interior mode and the amount of touch interactions on the exterior mode.

At the conclusion of the study, data was exported for analysis in SPSS V20 for the PC. From here, a one-tailed ANOVA test was performed on the data to determine whether a significant difference of WTA values was evident based on the feedback sound. The aim of this analysis, was to observe any impact on endowment induced by auditory feedback.

3.7 Appropriateness of research design

To establish the relationship between audio feedback and perceived value, research had to be conducted in a quantitative fashion that pertained to manipulation of variables and observing the outcome. For investigating such a causal relationship, an experimental approach was adopted as the guiding research design for the study. Although an alternative design, such as an ethnography, might have utilised a more qualitative form of research, the measurement of the endowment effect is better suited as a quantitative metric. This is demonstrated in numerous past studies of the endowment effect, including the work of Kahneman et al. (1990), Brasel and Gips (2014), and Peck and Shu (2009) (as discussed in Section 2.2.3), which pertained on the most part to experimental research and made use of quantitative measurements. The virtual environment of this research however, would complicate existing traditions of endowment effect research, which have on the most part pertained to physical

possessions. It became clear that to sustain this approach, a new instrument would have to be designed for the purpose of facilitating user interaction with an e-book. Initial conceptions of this instrument drew inspiration from Raban and Rafaeli's (2006) usage of the business simulation game *Lemonade Stand* by Bob Jamison for an investigation into the prevalence of the endowment effect in an intangible, digital context. This concept was consolidated into a far more minimal approach consisting of a web-based browser application dubbed *Bookseller*.

3.8 Ethical considerations

Although users were informed in a general sense regarding the study's intention and topic, they were intentionally not made aware of key specifics. No mention was made of audio feedback as a prominent element of the study, nor were users informed that each of them were assigned one of five random audio feedback sounds (including silence), to eliminate any potential for bias that might arise if the user was made aware of the different sounds they would experience. It was thought that, for example, a user might become more pre-occupied by the sound effect itself, rather than associating it with the action of touch, and in so doing, disrupt the illusion.

3.9 Internal and external validity

The internal validity of the research design was challenged in regards to fostering a sense of loss aversion amongst users. As noted in section 2.2.3, experienced traders who tend to think more rationally regarding their purchases are less affected by the endowment effect (List, 2004). In such cases, the certainty of an object's true value influences endowment (List, 2011). If it is understood by a participant, during the procedure of the research, that their ownership of the e-book is transient and therefore meaningless, it has the capacity to undermine their perception of the e-book as an entity in their possession. Conversely, if the user cannot benefit from the virtual currency for which they might sell the e-book, perceived value of the virtual currency itself is undermined. The narrative back story was developed to address this concern, but it is effective only to the extent that a user is willing to indulge the illusion of ownership, which itself is fragile and dependent on the point of reference (Knetsch & Wong, 2009).

The study was also challenged in terms of external validity. Although the sample included a variety of ages and nationalities, controlling for other demographics such as digital literacy was not addressed. A convenience sample approach in general has the potential to limit the representativeness of the study. The participants' choices of mobile platforms also have the potential to affect their experiences with the instrument. For this reason the device used by every user was recorded to examine such deviations. Each user's different volume setting might have also threatened validity. For this reason users were prompted to set their device's volume to maximum for participation in the study.

3.10 Summary

The purpose of this study was to examine how audio feedback, complementing haptic interaction, affects a person's perceived value of an e-book. Central to this is the phenomenon of the endowment effect: the tendency of people to value items in their possession higher than if they were paying to acquire it. The endowment effect is intensified by physical interaction, and combined with the ambiguous sense of ownership in regards to digital goods, it is diminished in virtual environments. Raban and Rafaeli's (2006) methodology served to inform the conception of a new research instrument intended to measure the prevalence of endowment in regards to an intangible good. The independent variable, in this case, was the sound implemented for auditory feedback. The dependent variable was the WTA value specified by a person in regards to an e-book seen to be in their possession.

Testing this relationship required an experimental approach, in which users were invited to experience interaction with an e-book, given certain factors, and then indicate their perceived value. The proposed experiment had to be digital and designed to be used with a touch screen. This intention was fulfilled by the *Bookseller* web application; the instrument upon which the experiment would hinge. From the main interface of this application, users indicated the price at which they would be willing to sell a given e-book that was presented as both a 3D model, and in page-to-page layout. A variety of sounds were considered for testing, and these pertained to two dimensions: spectral width and frequency.

4. Results and analysis

Upon completion of the data collection phase, the data stored on the SQL web server was exported as comma-separated values to SPSS v22 for the PC. Records where a participant had neglected to set a price were omitted, totalling a sample size of 132. In this chapter the data collected from *Bookseller* is presented and analysed in order to answer the research questions

4.1 Sound versus selling price

The mean selling prices for each of the individual sounds were compared to determine if there were any waveforms that correlated with a higher value, and hence, address the first research question: to what extent does audio feedback impact perceived ownership. A one-way ANOVA test was conducted to compare the effect of sound on the participant's selling price. The subsequent analysis, as seen in Tables 4.1, 4.2 and 4.3, showed that the highest mean selling price was associated with sound two, the high frequency tone (M = 16.72). Sound one, the low frequency tone, represented the lowest mean (M = 8.92). Both noise profiles, sounds three and four, yielded similar means (M_3 = 10.84, M_4 = 10.65). Sound five, the silent control group, had a mean of 10.00.

Table 4.1

Sound versus selling price descriptives

Sound	N	Mean ($)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	8.92	8.80	1.63	5.57	12.27	1.79	43.53
2 (high frequency tone)	21	16.72	12.72	2.78	10.93	22.51	3.11	46.77
3 (low frequency noise)	36	10.84	8.78	1.46	7.87	13.82	1.29	40.00
4 (high frequency noise)	20	10.65	9.38	2.10	6.25	15.04	2.05	35.09
5 (Silence)	26	10.00	7.03	1.38	7.16	12.84	2.05	30.85
Total	132	11.16	9.51	0.83	9.52	12.80	1.29	46.77

Table 4.2

Sound versus selling price ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	839.01	4.00	209.75	2.42	.05
Within Groups	11016.69	127.00	86.75		
Total	11855.70	131.00			

Table 4.3

Sound versus selling price multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	-7.80	2.67	0.03*	-15.19	-0.42
	3	-1.93	2.32	0.92	-8.36	4.50
	4	-1.73	2.71	0.97	-9.22	5.76
	5	-1.08	2.52	0.99	-8.04	5.88
2 (high frequency tone)	1	7.80	2.67	0.03*	0.42	15.19
	3	5.87	2.56	0.15	-1.20	12.95
	4	6.07	2.91	0.23	-1.98	14.13
	5	6.72	2.73	0.11	-0.84	14.28
3 (low frequency noise)	1	1.93	2.32	0.92	-4.50	8.36
	2	-5.87	2.56	0.15	-12.95	1.20
	4	0.20	2.60	1.00	-6.99	7.39
	5	0.85	2.40	1.00	-5.79	7.48
4 (high frequency noise)	1	1.73	2.71	0.97	-5.76	9.22
	2	-6.07	2.91	0.23	-14.13	1.98
	3	-0.20	2.60	1.00	-7.39	6.99
	5	0.65	2.77	1.00	-7.02	8.31
5 (Silence)	1	1.08	2.52	0.99	-5.88	8.04
	2	-6.72	2.73	0.11	-14.28	0.84
	3	-0.85	2.40	1.00	-7.48	5.79
	4	-0.65	2.77	1.00	-8.31	7.02

4.2 Sound versus interaction

The e-book could be examined by the participant in two modes; interior and exterior. When in exterior mode, the book was presented closed such that the participant could interact with the outside cover in a 3D interface. For interior mode, the participant had access to the content of the e-book as presented in a page-by-page format typical of a standard e-reader. The impact of sound type on each of these interaction modes was analysed to provide insight regarding the third research question: to what extent does audio feedback impact the propensity for user interaction.

4.2.1 Exterior mode

The level of exterior interaction for each participant was compared with the respective feedback sound to see if any particular waveforms prompted a greater degree of interaction. One way ANOVA tests were executed for comparing exterior interaction metrics to the feedback sounds. Exterior mode interaction was measured in three dimensions. External touch time, the first of these metrics, refers to the total amount of time in milliseconds that a participant held their finger on the screen in order to interact with the e-book exterior. The second metric, external touches, refers to the discrete count of times the participant pressed their finger on the e-book exterior. The third measurement pertains to a ratio of the first two metrics to articulate an average time per touch.

Touch time

As shown in Tables 4.4, 4.5 and 4.6, participants assigned sound one had the highest mean external touch time (M = 8095.69 milliseconds). This was followed by sound two (M = 7818.67), sound five/silence (M = 7202.00), sound four (M = 7117.10), and sound three (M = 6182.22).

Table 4.4

Sound versus external touch time descriptives

	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	8095.69	4678.54	868.78	6316.07	9875.31	2003.00	17312.00
2 (high frequency tone)	21	7818.67	5299.83	1156.52	5406.21	10231.12	120.00	18814.00
3 (low frequency noise)	36	6182.22	4261.95	710.33	4740.19	7624.26	0.00	16430.00
4 (high frequency noise)	20	7117.10	6648.62	1486.68	4005.45	10228.75	0.00	24572.00
5 (Silence)	26	7202.00	4900.81	961.13	5222.52	9181.48	0.00	22632.00
Total	132	7205.46	5033.82	438.14	6338.72	8072.20	0.00	24572.00

Table 4.5

Sound versus external touch time ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	68728247.91	4.00	17182061.98	0.67	0.61
Within Groups	3250723134.90	127.00	25596245.16		
Total	3319451382.81	131.00			

Table 4.6

Sound versus external touch time multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	277.02	1449.65	1.00	-3734.69	4288.74
	3	1913.47	1262.39	0.55	-1580.03	5406.96
	4	978.59	1470.52	0.96	-3090.88	5048.06
	5	893.69	1366.42	0.97	-2887.68	4675.06
2 (high frequency tone)	1	-277.02	1449.65	1.00	-4288.74	3734.69
	3	1636.44	1389.20	0.76	-2207.97	5480.86
	4	701.57	1580.72	0.99	-3672.86	5075.99
	5	616.67	1484.37	0.99	-3491.11	4724.44
3 (low frequency noise)	1	-1913.47	1262.39	0.55	-5406.96	1580.03
	2	-1636.44	1389.20	0.76	-5480.86	2207.97
	4	-934.88	1410.96	0.96	-4839.52	2969.77
	5	-1019.78	1302.11	0.94	-4623.17	2583.62
4 (high frequency noise)	1	-978.59	1470.52	0.96	-5048.06	3090.88
	2	-701.57	1580.72	0.99	-5075.99	3672.86
	3	934.88	1410.96	0.96	-2969.77	4839.52
	5	-84.90	1504.75	1.00	-4249.10	4079.30
5 (Silence)	1	-893.69	1366.42	0.97	-4675.06	2887.68
	2	-616.67	1484.37	0.99	-4724.44	3491.11
	3	1019.78	1302.11	0.94	-2583.62	4623.17
	4	84.90	1504.75	1.00	-4079.30	4249.10

Touches

Of the external touch count metric, the results of which are shown in Tables 4.7, 4.8 and 4.9, sound two had the highest mean of touches (*M* = 8.57). This was followed by silence (*M* = 7.62), sound one (*M* = 6.93), sound three (*M* = 5.58), and sound four (*M* = 3.80).

Table 4.7

Sound versus external touch time descriptives

Sound	N	Mean (touches)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	6.93	5.84	1.08	4.71	9.15	2.00	28.00
2 (high frequency tone)	21	8.57	6.49	1.42	5.62	11.53	1.00	24.00
3 (low frequency noise)	36	5.58	5.32	0.89	3.78	7.38	0.00	29.00
4 (high frequency noise)	20	3.80	2.76	0.62	2.51	5.09	0.00	9.00
5 (Silence)	26	7.62	12.20	2.39	2.69	12.54	0.00	54.00
Total	132	6.48	7.29	0.63	5.23	7.74	0.00	54.00

Table 4.8

Sound versus external touch time ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	303.86	4.00	75.97	1.45	0.22
Within Groups	6651.11	127.00	52.37		
Total	6954.97	131.00			

Table 4.9

Sound versus external touch time multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	-1.64	2.07	0.93	-7.38	4.10
	3	1.35	1.81	0.95	-3.65	6.34
	4	3.13	2.10	0.57	-2.69	8.95
	5	-0.68	1.95	1.00	-6.09	4.72
2 (high frequency tone)	1	1.64	2.07	0.93	-4.10	7.38
	3	2.99	1.99	0.56	-2.51	8.49
	4	4.77	2.26	0.22	-1.49	11.03
	5	0.96	2.12	0.99	-4.92	6.83
3 (low frequency noise)	1	-1.35	1.81	0.95	-6.34	3.65
	2	-2.99	1.99	0.56	-8.49	2.51
	4	1.78	2.02	0.90	-3.80	7.37
	5	-2.03	1.86	0.81	-7.19	3.12
4 (high frequency noise)	1	-3.13	2.10	0.57	-8.95	2.69
	2	-4.77	2.26	0.22	-11.03	1.49
	3	-1.78	2.02	0.90	-7.37	3.80
	5	-3.82	2.15	0.39	-9.77	2.14
5 (Silence)	1	0.68	1.95	1.00	-4.72	6.09
	2	-0.96	2.12	0.99	-6.83	4.92
	3	2.03	1.86	0.81	-3.12	7.19
	4	3.82	2.15	0.39	-2.14	9.77

Ratio

For each participant, the mean external touch time was divided by the corresponding mean touch count to establish an external time/touch ratio. A one-way ANOVA test was

executed to examine the relationship of this ratio to the feedback sound, and the outcome of this analysis is displayed in Tables 4.10, 4.11 and 4.12. The highest mean ratio corresponded with sound four (*M* = 1801.62 milliseconds per touch). This was followed by silence (*M* = 1788.13), sound one (*M* = 1649.21), sound three (*M* = 1216.26), and sound two (*M* = 1098.54).

Table 4.10

Sound versus external time touch ratio descriptives

Sound	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	1649.21	1295.98	240.66	1156.25	2142.18	356.83	5573.00
2 (high frequency tone)	21	1098.54	701.15	153.00	779.38	1417.70	88.38	2521.00
3 (low frequency noise)	36	1216.26	1025.99	171.00	869.12	1563.41	0.00	4376.50
4 (high frequency noise)	20	1801.62	1616.83	361.53	1044.91	2558.32	0.00	6143.00
5 (Silence)	26	1788.13	1588.23	311.48	1146.63	2429.63	0.00	5671.00
Total	132	1493.98	1288.04	112.11	1272.20	1715.76	0.00	6143.00

Table 4.11

Sound versus external time/touch ratio ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	10901703.62	4.00	2725425.90	1.68	.159
Within Groups	206433207.90	127.00	1625458.33		
Total	217334911.52	131.00			

Table 4.12

Sound versus external time/touch ratio multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	550.67	365.31	0.56	-460.28	1561.62
	3	432.95	318.12	0.65	-447.41	1313.31
	4	-152.40	370.57	0.99	-1177.91	873.10
	5	-138.92	344.34	0.99	-1091.82	813.98
2 (High frequency tone)	1	-550.67	365.31	0.56	-1561.62	460.28
	3	-117.72	350.08	1.00	-1086.51	851.07
	4	-703.08	398.34	0.40	-1805.43	399.28
	5	-689.59	374.06	0.35	-1724.75	345.56
3 (Low frequency noise)	1	-432.95	318.12	0.65	-1313.31	447.41
	2	117.72	350.08	1.00	-851.07	1086.51
	4	-585.35	355.56	0.47	-1569.32	398.61
	5	-571.87	328.13	0.41	-1479.93	336.18
4 (High frequency noise)	1	152.40	370.57	0.99	-873.10	1177.91
	2	703.08	398.34	0.40	-399.28	1805.43
	3	585.35	355.56	0.47	-398.61	1569.32
	5	13.48	379.20	1.00	-1035.89	1062.86
5 (Silence)	1	138.92	344.34	0.99	-813.98	1091.82
	2	689.59	374.06	0.35	-345.56	1724.75
	3	571.87	328.13	0.41	-336.18	1479.93
	4	-13.48	379.20	1.00	-1062.86	1035.89

4.2.2 Interior mode

The level of interior interaction for each participant was compared with the respective feedback sounds to see if any waveforms prompted a greater degree of interaction. Four one-way ANOVA tests examined the effect of feedback sound on interior interaction. This interaction was measured in four dimensions. The first of these measurements,

internal touch time, refers to the total amount of time in milliseconds the participant held their finger on the screen in order to interact with the e-book interior. Interior touches, the second metric, refers to the discrete count of times the participant pressed their finger on the e-book interior. The third measurement pertains to a ratio of the first two to articulate an average time per touch. The fourth measurement, reading time, refers to the participant's total time spent in interior mode.

Touch time

As shown in Tables 4.13, 4.14 and 4.15, participants assigned sound two had the highest mean interior touch time (*M* = 12829.76 milliseconds). This was followed by sound three (*M* = 11853.97), silence (*M* = 10996.58), sound four (*M* = 9604.45), and sound one (*M* = 8668.00).

Table 4.13

Sound versus internal touch time descriptives

Sound	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	8668.00	11231.94	2085.72	4395.60	12940.40	351.00	47579.00
2 (High frequency tone)	21	12829.76	18232.35	3978.63	4530.50	21129.03	136.00	73809.00
3 (Low frequency noise)	36	11853.97	21379.24	3563.21	4620.28	19087.67	0.00	109294.00
4 (High frequency noise)	20	9604.45	8876.26	1984.79	5450.23	13758.67	0.00	26285.00
5 (Silence)	26	10996.58	27496.42	5392.49	-109.47	22102.62	0.00	143707.00
Total	132	10799.55	18914.13	1646.26	7542.84	14056.25	0.00	143707.00

Table 4.14

Sound versus internal touch time ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	287918238.649	4	71979559.662	.196	.94
Within Groups	46576562928.078	127	366744589.985		
Total	46864481166.727	131			

Table 4.15

Sound versus internal touch time multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	-4161.76	5487.29	0.94	-19347.08	11023.56
	3	-3185.97	4778.46	0.96	-16409.71	10037.76
	4	-936.45	5566.29	1.00	-16340.39	14467.49
	5	-2328.58	5172.23	0.99	-16641.99	11984.84
2 (High frequency tone)	1	4161.76	5487.29	0.94	-11023.56	19347.08
	3	975.79	5258.46	1.00	-13576.26	15527.84
	4	3225.31	5983.42	0.98	-13332.96	19783.58
	5	1833.18	5618.68	1.00	-13715.74	17382.11
3 (Low frequency noise)	1	3185.97	4778.46	0.96	-10037.76	16409.71
	2	-975.79	5258.46	1.00	-15527.84	13576.26
	4	2249.52	5340.84	0.99	-12530.51	17029.56
	5	857.40	4928.78	1.00	-12782.33	14497.12
4 (High frequency noise)	1	936.45	5566.29	1.00	-14467.49	16340.39
	2	-3225.31	5983.42	0.98	-19783.58	13332.96
	3	-2249.52	5340.84	0.99	-17029.56	12530.51
	5	-1392.13	5695.86	1.00	-17154.62	14370.37
5 (Silence)	1	2328.58	5172.23	0.99	-11984.84	16641.99
	2	-1833.18	5618.68	1.00	-17382.11	13715.74
	3	-857.40	4928.78	1.00	-14497.12	12782.33
	4	1392.13	5695.86	1.00	-14370.37	17154.62

Touches

As shown in Tables 4.16, 4.17 and 4.18, sound four had the highest mean of touches (*M* = 14.55). This was followed by sound two (*M* = 14.19), sound three (*M* = 13.94), silence (*M* = 13.38), and sound one (*M* = 11.31).

Table 4.16

Sound versus internal touches descriptives

Sound	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	11.31	8.03	1.49	8.26	14.37	2.00	34.00
2 (High frequency tone)	21	14.19	13.36	2.92	8.11	20.27	1.00	44.00
3 (Low frequency noise)	36	13.94	15.33	2.55	8.76	19.13	0.00	71.00
4 (High frequency noise)	20	14.55	13.41	3.00	8.28	20.82	0.00	57.00
5 (Silence)	26	13.38	12.35	2.42	8.40	18.37	0.00	42.00
Total	132	13.39	12.66	1.10	11.21	15.57	0.00	71.00

Table 4.17

Sound versus internal touches ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	176.86	4.00	44.21	0.27	0.90
Within Groups	20826.44	127.00	163.99		
Total	21003.30	131.00			

Table 4.18

Sound versus internal touches multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	-2.88	3.67	0.93	-13.03	7.27
	3	-2.63	3.20	0.92	-11.48	6.21
	4	-3.24	3.72	0.91	-13.54	7.06
	5	-2.07	3.46	0.97	-11.65	7.50
2 (High frequency tone)	1	2.88	3.67	0.93	-7.27	13.03
	3	0.25	3.52	1.00	-9.48	9.98
	4	-0.36	4.00	1.00	-11.43	10.71
	5	0.81	3.76	1.00	-9.59	11.20
3 (Low frequency noise)	1	2.63	3.20	0.92	-6.21	11.48
	2	-0.25	3.52	1.00	-9.98	9.48
	4	-0.61	3.57	1.00	-10.49	9.28
	5	0.56	3.30	1.00	-8.56	9.68
4 (High frequency noise)	1	3.24	3.72	0.91	-7.06	13.54
	2	0.36	4.00	1.00	-10.71	11.43
	3	0.61	3.57	1.00	-9.28	10.49
	5	1.17	3.81	1.00	-9.37	11.71
5 (Silence)	1	2.07	3.46	0.97	-7.50	11.65
	2	-0.81	3.76	1.00	-11.20	9.59
	3	-0.56	3.30	1.00	-9.68	8.56
	4	-1.17	3.81	1.00	-11.71	9.37

Ratio

As shown in Tables 4.19, 4.20 and 4.21, sound three had the highest internal time/touch ratio (*M* = 1062.09 ms/touch). This was followed by sound one (*M* = 949.07), sound two (*M* = 745.97), sound four (*M* = 686.06), and silence (*M* = 579.17).

Table 4.19

Sound versus internal time/touch ratio descriptives

	N	Mean (ms/touch)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	949.07	1533.54	284.77	365.75	1532.40	166.96	7929.83
2 (High frequency tone)	21	745.97	800.18	174.61	381.73	1110.20	136.00	3690.45
3 (Low frequency noise)	36	1062.09	2457.34	409.56	230.64	1893.53	0.00	14750.00
4 (High frequency noise)	20	686.06	673.26	150.55	370.97	1001.16	0.00	3099.14
5 (Silence)	26	579.17	630.78	123.71	324.40	833.95	0.00	3421.60
Total	132	834.87	1546.00	134.56	568.68	1101.07	0.00	14750.00

Table 4.20

Sound versus internal time/touch ratio ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4545547.74	4.00	1136386.94	0.47	.76
Within Groups	308561485.62	127.00	2429618.00		
Total	313107033.36	131.00			

Table 4.21

Sound versus internal time/touch ratio multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	203.11	446.63	0.99	-1032.87	1439.09
	3	-113.01	388.93	1.00	-1189.33	963.31
	4	263.01	453.06	0.98	-990.76	1516.78
	5	369.90	420.98	0.90	-795.11	1534.91
2 (high frequency tone)	1	-203.11	446.63	0.99	-1439.09	1032.87
	3	-316.12	428.00	0.95	-1500.56	868.32
	4	59.90	487.01	1.00	-1287.83	1407.63
	5	166.79	457.32	1.00	-1098.78	1432.37
3 (low frequency noise)	1	113.01	388.93	1.00	-963.31	1189.33
	2	316.12	428.00	0.95	-868.32	1500.56
	4	376.02	434.71	0.91	-826.97	1579.01
	5	482.91	401.17	0.75	-627.27	1593.09
4 (high frequency noise)	1	-263.01	453.06	0.98	-1516.78	990.76
	2	-59.90	487.01	1.00	-1407.63	1287.83
	3	-376.02	434.71	0.91	-1579.01	826.97
	5	106.89	463.60	1.00	-1176.07	1389.85
5 (Silence)	1	-369.90	420.98	0.90	-1534.91	795.11
	2	-166.79	457.32	1.00	-1432.37	1098.78
	3	-482.91	401.17	0.75	-1593.09	627.27
	4	-106.89	463.60	1.00	-1389.85	1176.07

Reading time

The final metric of interior interaction was the reading time. As shown in Tables 4.22, 4.23 and 4.24, sound one had the highest (4731.79 milliseconds). Sound three, sound four, and silence had comparable means (M_3 = 3172.81, M_4 = 3608.40, M_5 = 3824.35). Sound two, the high pitch tone, had the lowest mean reading time (M = 2567.00).

Table 4.22

Sound versus reading time descriptives

Sound	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	4731.79	6449.20	1197.59	2278.65	7184.94	892.00	25735.00
2 (high frequency tone)	21	2567.00	2950.43	643.84	1223.98	3910.02	451.00	14650.00
3 (low frequency noise)	36	3172.81	3239.34	539.89	2076.77	4268.84	930.00	18117.00
4 (high frequency noise)	20	3608.40	2602.06	581.84	2390.60	4826.20	1092.00	9269.00
5 (Silence)	26	3824.35	6841.89	1341.81	1060.85	6587.85	846.00	35759.00
Total	132	3613.27	4842.79	421.51	2779.42	4447.11	451.00	35759.00

Table 4.23

Sound versus reading ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	67413200.64	4.00	16853300.16	0.71	.59
Within Groups	3004879029.08	127.00	23660464.80		
Total	3072292229.72	131.00			

Table 4.24

Sound versus reading multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	2164.79	1393.76	0.53	-1692.24	6021.83
	3	1558.99	1213.72	0.70	-1799.81	4917.79
	4	1123.39	1413.83	0.93	-2789.17	5035.96
	5	907.45	1313.73	0.96	-2728.13	4543.02
2 (high frequency tone)	1	-2164.79	1393.76	0.53	-6021.83	1692.24
	3	-605.81	1335.64	0.99	-4301.99	3090.38
	4	-1041.40	1519.77	0.96	-5247.16	3164.36
	5	-1257.35	1427.13	0.90	-5206.74	2692.04
3 (low frequency noise)	1	-1558.99	1213.72	0.70	-4917.79	1799.81
	2	605.81	1335.64	0.99	-3090.38	4301.99
	4	-435.59	1356.56	1.00	-4189.69	3318.50
	5	-651.54	1251.90	0.99	-4116.00	2812.92
4 (high frequency noise)	1	-1123.39	1413.83	0.93	-5035.96	2789.17
	2	1041.40	1519.77	0.96	-3164.36	5247.16
	3	435.59	1356.56	1.00	-3318.50	4189.69
	5	-215.95	1446.73	1.00	-4219.58	3787.69
5 (Silence)	1	-907.45	1313.73	0.96	-4543.02	2728.13
	2	1257.35	1427.13	0.90	-2692.04	5206.74
	3	651.54	1251.90	0.99	-2812.92	4116.00
	4	215.95	1446.73	1.00	-3787.69	4219.58

4.2.3 Exposure

The aggregate exposure time for each participant was obtained by adding their read time and corresponding external touch time. This measurement was intended to denote the amount of time in milliseconds each participant spent interacting with the e-book. Using a one-way ANOVA test, each participant's allocated sound was compared with their

exposure time to determine correlation. As shown in Table 4.25, sound one had the highest mean exposure time (*M* = 12827.48 milliseconds), followed by silence (*M* = 11026.35), sound four (*M* = 10725.50), sound two (*M* = 10385.67) and sound three (M = 9355.03).

Table 4.25

Sound versus exposure descriptives

Sound	N	Mean (ms)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1 (Low frequency tone)	29	12827.48	7036.02	1306.56	10151.12	15503.84	4109.00	28860.00
2 (high frequency tone)	21	10385.67	6279.23	1370.24	7527.40	13243.94	1110.00	25469.00
3 (low frequency noise)	36	9355.03	4746.43	791.07	7749.07	10960.99	1277.00	19258.00
4 (high frequency noise)	20	10725.50	7321.45	1637.13	7298.96	14152.04	1198.00	27394.00
5 (Silence)	26	11026.35	7482.74	1467.49	8004.00	14048.69	1725.00	38439.00
Total	132	10818.73	6527.02	568.10	9694.88	11942.57	1110.00	38439.00

Table 4.26

Sound vs exposure ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	199377786.417	4	49844446.604	1.18	.32
Within Groups	5381484047.765	127	42373890.140		
Total	5580861834.182	131			

Table 4.27

Sound vs exposure multiple comparisons

Sound		Mean Difference	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1 (Low frequency tone)	2	2441.82	1865.20	0.69	-2719.87	7603.50
	3	3472.45	1624.26	0.21	-1022.46	7967.37
	4	2101.98	1892.05	0.80	-3134.01	7337.98
	5	1801.14	1758.11	0.84	-3064.17	6666.45
2 (high frequency tone)	1	-2441.82	1865.20	0.69	-7603.50	2719.87
	3	1030.64	1787.42	0.98	-3915.79	5977.06
	4	-339.83	2033.84	1.00	-5968.20	5288.53
	5	-640.68	1909.86	1.00	-5925.95	4644.60
3 (low frequency noise)	1	-3472.45	1624.26	0.21	-7967.37	1022.46
	2	-1030.64	1787.42	0.98	-5977.06	3915.79
	4	-1370.47	1815.42	0.94	-6394.39	3653.45
	5	-1671.32	1675.36	0.86	-6307.63	2965.00
4 (high frequency noise)	1	-2101.98	1892.05	0.80	-7337.98	3134.01
	2	339.83	2033.84	1.00	-5288.53	5968.20
	3	1370.47	1815.42	0.94	-3653.45	6394.39
	5	-300.85	1936.09	1.00	-5658.72	5057.02
5 (Silence)	1	-1801.14	1758.11	0.84	-6666.45	3064.17
	2	640.68	1909.86	1.00	-4644.60	5925.95
	3	1671.32	1675.36	0.86	-2965.00	6307.63
	4	300.85	1936.09	1.00	-5057.02	5658.72

4.3 Interaction versus selling price

To address the second research question, regarding the extent to which interactivity could impact the perceived value of an e-book, analyses were performed on the

relationship between interaction times and selling prices. Again, interaction times were considered with respect to the exterior and interior modes.

4.3.1 Exterior mode

The degree of a participant's external interaction, measured in exterior touch time and touches, was compared with their selling price to determine if interaction predicates changed perceived value. As shown in Tables 4.28 and 4.29, both cases showed a gradual downward trend.

Table 4.28

External touch time versus selling price regression

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.006	.727	1	130	.40	12.174	.000
Exponential	.007	.877	1	130	.351	8.991	.000

Table 4.29

External touches versus selling price regression

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.016	2.056	1	130	.15	12.215	-.163
Exponential	.012	1.594	1	130	.209	8.856	-.012

No interaction

To determine if any change in perceived value was preceded by absence of interaction with the book exterior, a one-way ANOVA was performed on the relationship of selling price to exterior touch time, and the results of this analysis are shown in Tables 4.30 and 4.31. Participants who registered 0 milliseconds of exterior touch time had a mean selling price of 5.66, compared to 11.47 for those who registered more.

Table 4.30

No external interaction versus selling price descriptives

	N	Mean ($)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No interaction	7	5.66	3.84	1.45	2.11	9.21	2.05	12.00
Interaction	125	11.47	9.65	0.86	9.76	13.18	1.29	46.77
Total	132	11.16	9.51	0.83	9.52	12.80	1.29	46.77

Table 4.31

No external interaction versus selling price ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	223.75	1.00	223.75	2.50	0.12
Within Groups	11631.95	130.00	89.48		
Total	11855.70	131.00			

4.3.2 Interior mode

The degree of a participant's interior interaction, measured in interior touch time, touches, and reading time, was compared with their selling price to determine if content interaction predicates changed perceived value. As shown in Tables 4.32, 4.33 and 4.34, all three cases showed a gradual downward trend.

Table 4.32

Internal touch time versus selling price regression

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.010	1.295	1	130	.257	11.698	.000
Exponential	.011	1.406	1	130	.238	8.588	.000

Table 4.33

Internal touches versus selling price regression

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.036	4.881	1	130	.029	13.072	-.143
Exponential	.027	3.559	1	130	.061	9.393	-.010

Table 4.34

Read time versus selling price regression

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.016	2.117	1	130	.148	12.057	.000
Exponential	.027	3.594	1	130	.06	9.028	.000

No interaction

To determine if any change in perceived value was preceded by absence of interaction with the book interior, a one-way ANOVA was performed on the relationship of selling price to interior touch time and the results of this analysis are shown in Tables 4.35 and 4.36. Participants who registered 0 milliseconds of interior touch time had a mean selling price of 14.31, compared to 11.09 for those who did.

Table 4.35

No internal interaction versus selling price descriptives

	N	Mean ($)	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No Interaction	3	14.31	4.77	2.75	2.47	26.15	11.14	19.79
Interaction	129	11.09	9.59	0.84	9.41	12.76	1.29	46.77
Total	132	11.16	9.51	0.83	9.52	12.80	1.29	46.77

Table 4.36

No internal interaction versus selling price ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30.48	1.00	30.48	0.34	0.56
Within Groups	11825.22	130.00	90.96		
Total	11855.70	131.00			

4.3.3 Total exposure

Linear and exponential regressions were conducted to determine if a participant's exposure time influenced their selling price. The output, as shown in Table 4.37 and illustrated in Figures 4.1 and 4.2, followed a gradual downward trend.

Table 4.37

Total Exposure vs Selling Price ANOVA

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.023	3.051	1	130	.08	13.547	.00
Exponential	.034	4.599	1	130	.03	10.438	.00

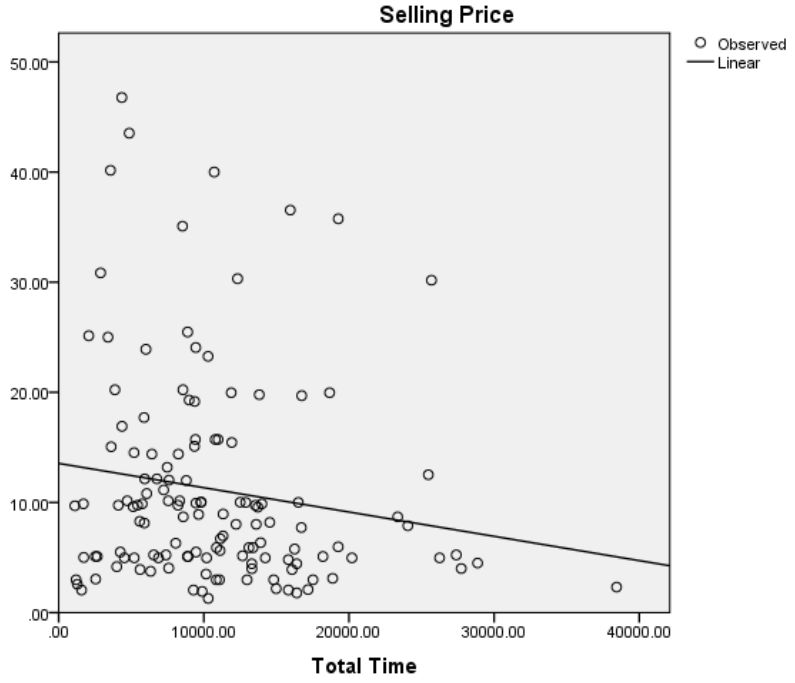

Figure 4.1: Exposure versus selling price linear

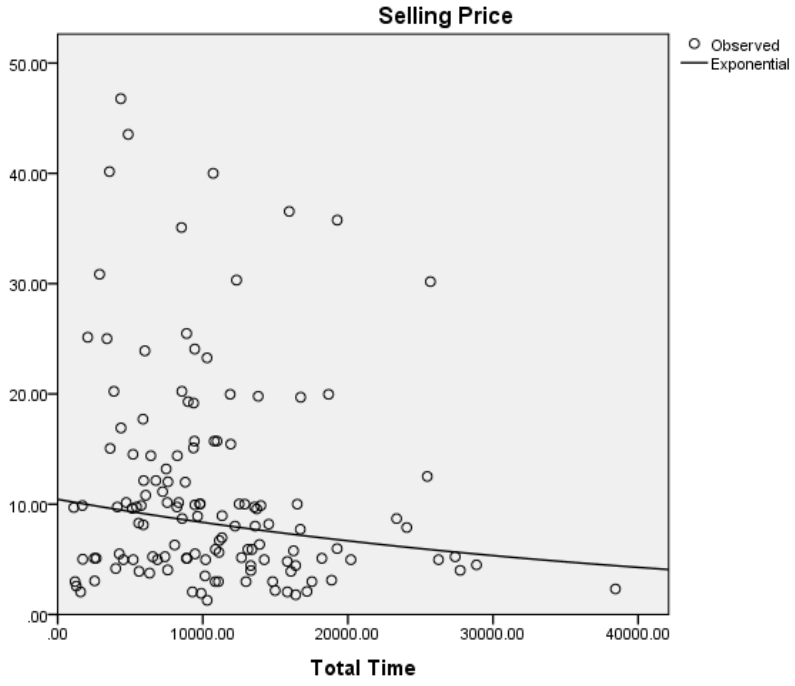

Figure 4.2: Exposure versus selling price exponential

4.4 Summary

In this chapter, data collected from the Bookseller application were organised and analysed so the information could be considered in the context of the hypotheses. Paying consideration to any usability issues of the instrument, the data was obtained from user analytics of the Bookseller application, and one way ANOVA tests, cross tabulations, and linear regressions were used to examine the various factors in regards to user interaction. In the following discussion chapter, the results will be examined in greater detail for their various implications to the hypothesis among other auxiliary findings.

5. Discussion

5.1 Introduction

By the conclusion of the data collection phase, a total of 180 participants had contributed to the sample. After removing the records of participants who didn't specify a selling price, this number was reduced to 132. The final sample size was far below the optimal amount for a statistically significant sample, as calculated to be 305 in Section 3.3. To reiterate, this number was reached by priori analysis, taking into account power level, significance level, and population effect size. The subsequent inadequate sample can be attributed to time constraints on the study's data collection phase, in addition to an incentive that could not attract the necessary level of interest. Nevertheless, the data collected by *Bookseller*, and the subsequent analysis, provided some key insights regarding the research questions. In addition, while noting the small sample size, several statistically significant results were obtained.

5.2 To what extent does audio feedback impact perceived ownership of an e-book?

The first research question was the most central to the goals of the study. As defined in Section 2.2.3, the endowment effect is defined as the phenomenon observed when an item in an individual's possession is perceived as more valuable by that individual. Although it is more often that the endowment effect is quantified by a ratio between an individual's WTP (willingness to pay for a good) and WTA (willingness to accept money for a good) values for a particular item, WTA by itself can be considered a valid measurement (Brasel & Gips, 2014). The specified selling prices of each participant using the Bookseller application were therefore interpreted to denote the individual intensity of the endowment effect. For each treatment group in the experiment, having each been assigned a particular feedback sound effect, the mean selling prices were compared. To reiterate, these five treatment groups consisted of four audio feedback sounds: the first of these, sound one, was a 200hz low frequency tone comparable to G in octave 3 on a keyboard; Sound two was, a 640hz high frequency tone comparable to D# in octave 5; Sound three was a lower frequency *pink* noise spectrum; and sound four

was a higher frequency *blue* noise spectrum, both of which were comparable to the sound of TV static. The fifth treatment, the control group, was silence.

As discussed in Section 2.2.3, the sense of attachment to a possession known as the endowment effect is quantified by an overvaluation of that possession. The endowment effect is intensified not only through physical contact, but also, through vivid sensory imagery, imagined physical contact. The use of synchronised sound to sustain sensory immersion was the focus of the experiment. It was hypothesised that the presence of any audio feedback would correlate with an elevated sense of perceived value and hence perceived ownership. When the data was analysed, it revealed this hypothesis was only partially correct. The results infer that only certain sounds increase perceived ownership. Overall, the sound versus selling price ANOVA analysis yielded a degree of statistical significance that affirmed the validity of this conclusion ($p = 0.05$).

Consistent with the endowment effect, participants demonstrated a tendency to overvalue the e-book portrayed to be in their possession All five treatments indicated mean selling prices that were within the upper range of modern e-book retailers. The mean selling price by control group participants was $10. By comparison, the typical price of e-book bestsellers is closer to the range of $7 (Bellis, 2015), representing an overvaluation of 43%. Notably, this was despite the likelihood that few of the participants, by design of the study, would have been familiar with the particular book, if any. However, it must also be accounted for that a certain share of participants were unaware of typical e-book price owing to limited experience with e-books in general. The results demonstrated an observable difference between the sounds themselves. The highest increased value was associated with the high pitch tone ($M = 16.73$), shown to have a perceived value 67% higher than the control group mean ($M = 10.00$). Jousmaki and Hari's (1998) parchment-skin illusion findings corroborate that the most visceral impact on perceived value is prompted by a high pitch tone. As discussed in Section 2.4.3, the parchment-skin illusion experiment concluded that higher frequencies of audio feedback sounds were sufficient to influence a user's haptic perception into recognising a dryer paper-like surface. The true significance of higher frequencies to this phenomenon is unclear and invites further investigation.

The low frequency tone represented the lowest valued sound (M = 8.92); a 11% decrease in perceived value from the control group mean (M = 10.00). Participants assigned the pink and blue noise signals (M_3 = 10.84, M_4 = 10.65) expressed mean selling prices that were 8% and 7% respectively above the control group mean. These three means were statistically equal to the control group (p_1 = 0.99, p_3 = 1.00, p_4 = 1.00). Participants assigned to the control group had the second lowest mean selling price. At $10.00, the control group had a mean selling price 10% below the total mean of all groups combined (M = 11.16).

To confirm this finding, a separate ANOVA analysis was conducted to establish the variation between the mean selling price of sound two and the mean selling prices of all other sounds grouped together, the results of which are displayed in Tables 5.1 and 5.2. The analysis further confirmed the correlation (t = 0.03).

Table 5.1

Sound two vs selling price descriptives

	N	Mean ($)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
Sound two (high frequency tone)	21	16.72	12.72	2.78	10.93	22.51	3.11	46.77
Other	111	10.12	8.45	.80	8.52	11.70	1.29	43.53
Total	132	11.16	9.51	.83	9.52	12.80	1.29	46.77

Table 5.2

Sound two vs selling price ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	772.19	1	772.19	9.06	.003
Within groups	11083.51	130	85.26		

Total	11855.70	131			

The control group had the lowest standard deviation of all the sounds (*SD* = 7.03), implying that the presence of audio feedback had varying degrees of effect on each participant. As shown in Table 4.1 , the effect was most volatile in the case of the high frequency tone (*SD* = 12.72). A potential factor for this variation is each participant's individual NFT (need for touch) index. As mentioned in Section 2.4.2, the significance of NFT is demonstrable in a physical retail context, where an individual with a higher NFT index would be more inclined to prioritise the feel of products as part of their value judgement process (Peck & Childers, 2003).

The relevance of NFT in the experiment alludes to another, perhaps more significant, factor: the degree of interaction between each participant and the e-book. The second research question addresses this potential.

5.3 To what extent does interactivity impact perceived ownership of an e-book?

As highlighted in Section 2.2.4, touching and holding an item in a retail context can have a significant positive effect on an individual's perceived ownership of a product (Peck & Shu, 2009). Proportional to the vividness of the sensory information, it is also evidenced that even imagined touch in digital contexts is capable of sustaining and intensifying the endowment effect (Peck et al., 2013). The second research question addressed this circumstance and investigated whether a participant's interaction with an e-book affected their perceived ownership, and hence, their perceived value, of that e-book.

In Section 2.2.3, it is noted that the endowment effect can double the perceived value of an item (Levy, 1997). This can take effect within seconds of coming into physical contact with that item, and when examining objects for an evaluation of their value, individuals tend to take no more than 10 seconds (Strahilevitz & Loewenstein, 1998). The data from *Bookseller* corroborates this in a virtual environment, in which the mean external touch time and read time add up to approximately 10 seconds. However, as

noted in Section 2.2.3, duration is expected to correlate with greater attachment and perceived value, and this change can be significant in as little as 30 seconds (Strahilevitz & Loewenstein, 1998). The linear and exponential regressions portrayed in Table 4.37 instead showed that the duration of exposure had a negative effect on the selling price. Despite a low R^2 value ($R^2 = 0.03$), denoting that only 3% of the variation was accounted for, the exponential regression in particular was statistically significant ($p = 0.03$). All other underlying interaction metrics, as represented in Tables 4.28, 4.29, 4.32 and 4.33, corroborated this trend.

The reason that exposure duration seemed to have a negative effect on participant attachment is unclear. One explanation is that user frustration with the interface was detrimental to the sense of attachment. As noted in Section 2.2.3, such negative feelings can diminish the endowment effect (Lin, Chuang, Kao & Kung, 2006). A facility to express general comments about the study included in the *Bookseller* application alluded to some shared participant attitudes. Indeed, some participants felt frustration with the instrument interface in both technical and usability terms:

- “Interface had a lot of issues on my Android device.”
- “Book pages were difficult to turn. And I couldn't judge how much of the book I had read or how far to reach the end.”
- “I'm sort of confused.”
- “Could not dial in the 3.99 price I wanted.”

A certain consensus exists among studies of the endowment effect and loss aversion that losses are twice as powerful, in a psychological sense, than respective gains (Tversky & Kahneman, 1992). Correspondingly, it is shown in Table 4.30 and 4.31 that participants who had no external interaction with the e-book had a mean selling price ($M = 5.66$) 50.6% lower than those who did ($M = 11.47$). It should be noted that the volume of participants who recorded no interaction was minimal, accounting for only 5% of

participants (N = 7). Although consistent with the endowment effect, the result was insufficient to yield true statistical significance ($p = 0.12$).

The observed effect was not reciprocated for interior interaction, as shown in Table 4.35 and 4.36. Participants who abstained from any interior interaction had a selling price ($M = 14.31$) 29% above those who did ($M = 11.09$). However, the volume of participants who registered no interaction with interior mode was even less than in the exterior mode: 2% of the sample size ($N = 3$). No resolute conclusions can be determined from this analysis ($p = 0.56$). It may indeed be possible that participants who took the time to read the e-book experienced a more subjective assessment of value. The content of the e-book could have a negative influence on perceived value. Further study is required to address this possibility.

It can be inferred that superfluous interaction with exterior mode - that is, interaction that offers no new information about the object to the participant and is engaged with for its own sake - had a quantifiable positive effect on the perception of value. However this was not proportional to the duration of the interaction. The effect of both exterior and interior interaction on perceived ownership was rendered uncertain due to insufficient sample sizes. This was particularly true for interior mode, concealing the true effect of functional interaction - interaction that is performed for the purposes of parsing the e-book content. Further study is required to clarify these results.

Another aspect of user interactivity to consider is how the various metrics were influenced by the feedback sound treatment groups. The third research question addressed this to determine whether any of the sounds in particular affected user behaviour.

5.4 To what extent does audio feedback impact interactivity with an e-book?

The third research question considered how auditory feedback might influence the e-book user experience and indeed the reading experience. Data was collected to

determine whether the assigned feedback sound had any impact on participants' interaction metrics.

As demonstrated in Tables 4.25 to 4.27, exposure times between sounds descended from sound one (M = 12827.48), silence (M = 11026.35), sound four (M = 10725.50), sound two (M = 10385.67) and sound three (M = 9355.03). the difference in total exposure times between sounds was small and statistically inconsequential (p = 0.32). From this research, at least, it can be concluded that none of the feedback sounds affected the amount of time participants took to examine the e-book holistically.

Many of the ancillary measurements likewise failed to establish statistical correlation. The high pitch tone, in addition to inducing the highest degree of perceived ownership of all the sounds, prompted the highest mean touch count in external mode (M = 8.57, p = 0.22) and the highest mean touch time in interior mode (M = 12829.76, p = 0.94). Regardless, the indicated statistical significance from these analyses undermined any meaningful conclusions.

Participants who heard the high pitch tone also had the lowest mean reading time of all the sounds (M = 2567.00) at 33% below the control group (M = 3824.35) . However, the strength of this finding is diminished by the lack of statistical significance (p = 0.59). The highest mean touch time in exterior mode (M = 8095.69, p = 0.61), and also the highest mean reading time (M = 4731.79, p = 0.59), corresponded with the low frequency tone; the sound associated with the lowest mean selling price of all treatments (M = 8.92). The highest mean touch count in interior mode corresponded with the blue noise (M = 14.55, p = 0.90), followed at a small margin by the pink noise (M = 14.19). In all cases, statistical correlation was not evident. The ratios between touch times and touches, both in external (p = 0.16) and internal modes (p = 0.76), were calculated in order to examine how the duration of each touch interaction might vary across feedback sounds. No such variation was apparent.

Much like the impact of audio feedback, each individual participant's NFT index is likely to factor into their degree of interaction with the instrument. However, unlike in

the test of sound versus selling price, the silent control group did not have the lowest standard deviation in regards to any of the interaction metrics, either interior and exterior. It is possible some sounds were simply less pleasurable to hear than others. Indeed, one participant made their discomfort with sound two apparent in the study comments, “The sounds were really upsetting for my brother who was just in the same room.”

Otherwise, based on the collected data, none of the audio feedback sounds influenced user behaviour. For longer durations of interaction or reading time, any such variations might become more apparent. With a larger sample size, and perhaps utilising more qualitative methods, a more definitive answer would be concluded.

5.5 Other findings

All participants were given the opportunity to enter into a raffle as an incentive for participation. The prize was a $100 gift voucher valid at one of three of the leading digital retailers (*Amazon*, *iTunes*, or *Google Play*) to be selected by the participant. Entries also required that participants specify their age via category of age groups; 18 - 24, 25 - 34, 35 - 44, or 45+. Out of 132 participants, 101 provided age information The data collected provided some additional insights outside the realm of the research questions.

Age versus selling price

The collected age data of participants was compared with their selling prices to examine the perceived value of e-books by age groups. Of those participants who specified their age, a one-way ANOVA on its relationship to the selling price was conducted. The results, shown in Table 5.3, 5.4 and 5.5, demonstrated that the perceived value of the e-book was highest amongst younger participants, represented by the lowest age group, 18 - 24. Participants in this age group valued the e-book (M = 11.80) 6% higher than the total mean price (M = 11.16), while perceived value tended to plateau at higher age groups. The three successive age groups, representing ages 25 and up (M_2 = 7.19, M_3 = 6.78, M_4 = 7.36), had a consistent specified value approximating at around $7.11, 36% less than the total mean (M = 11.16).

18 to 25 year olds fall within the boundaries of Generation Y. As the first generation to grow up with information technology, Generation Y is characterised by high sociability, techno-literacy and media savvy (Anil, Peng, & Kandampully, 2014). If participants born in the past 25 years are considered digital natives (Prensky, 2001), the results infer that digital immigrants have a diminished sense of ownership regarding e-books and indeed perhaps digital artefacts in general. Such a conclusion would allude to the potential role of digital literacy factoring into perceived ownership in regards to digital artefacts. Regardless, the statistical reliability of this analysis is insufficient to establish any conclusive argument (p = 0.13). A greater sample size might have provided more convincing insight.

Table 5.3

Age versus selling price descriptives

	N	Mean ($)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower Bound	Upper Bound		
N/A	31	13.35	11.56	2.08	9.11	17.59	2.09	43.53
18 – 24	73	11.80	9.46	1.11	9.59	14.00	1.29	46.77
25 – 34	17	7.19	4.78	1.16	4.73	9.65	1.79	20.23
35 – 44	9	6.78	6.90	2.30	1.47	12.08	2.05	24.07
45 +	2	7.36	3.38	2.39	-23.01	37.73	4.97	9.75
Total	132	11.16	9.51	0.83	9.52	12.80	1.29	46.77

Table 5.4

Age versus selling price ANOVA

	Sum of squares	*Df*	Mean square	*F*	Sig.
Between groups	648.66	4.00	162.17	1.84	.13
Within groups	11207.03	127.00	88.24		
Total	11855.70	131.00			

Table 5.5

Age versus selling price multiple comparisons

Age Group		Mean difference	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
N/A	18 - 24	1.56	2.01	0.94	-4.02	7.13
	25 - 34	6.16	2.84	0.20	-1.68	14.01
	35 - 44	6.58	3.56	0.35	-3.27	16.42
	45 +	5.99	6.85	0.91	-12.97	24.96
18 – 24	N/A	-1.56	2.01	0.94	-7.13	4.02
	25 - 34	4.61	2.53	0.37	-2.39	11.61
	35 - 44	5.02	3.32	0.56	-4.16	14.20
	45 +	4.44	6.73	0.96	-14.20	23.07
25 – 34	N/A	-6.16	2.84	0.20	-14.01	1.68
	18 - 24	-4.61	2.53	0.37	-11.61	2.39
	35 - 44	0.41	3.87	1.00	-10.30	11.13
	45 +	-0.17	7.02	1.00	-19.60	19.26
35 – 44	N/A	-6.58	3.56	0.35	-16.42	3.27
	18 - 24	-5.02	3.32	0.56	-14.20	4.16
	25 - 34	-0.41	3.87	1.00	-11.13	10.30
	45 +	-0.58	7.34	1.00	-20.91	19.74
45 +	N/A	-5.99	6.85	0.91	-24.96	12.97
	18 - 24	-4.44	6.73	0.96	-23.07	14.20
	25 - 34	0.17	7.02	1.00	-19.26	19.60
	35 - 44	0.58	7.34	1.00	-19.74	20.91

Preferred vendor versus selling price

Another notable indication from the data was a relationship between digital store preference and perceived e-book value. As mentioned in Section 5.2, the average price for best selling e-books has climbed to $7 this year, and the mean perceived value across all participants exceeded this by 43% (M = $10.00). As shown in Tables 5.6, 5.7

and 5.8, a preference for *iTunes* as a participant's digital vendor correlated with a 27% higher valuation of the e-book (M = 13.33) than the total mean (M = 10.49). Participants that preferred *Amazon* expressed a valuation (M = 10.08) 4% below the total mean and those who preferred *Google Play* were 52% below (M = 5.03). Presuming participants who signed up for the raffle were regular customers at the digital storefronts they had specified, it can be inferred from the data that *iTunes* users are inclined towards paying more for e-books than their peers at *Amazon* and *Google Play*. This is consistent with reports that users of the *Apple App* store spend more than four times as much money than the typical user of *Google Play* (App Annie, 2015). Nevertheless, the ANOVA test yielded a degree of statistical significance that was out of range (p = 0.09).

Table 5.6

Preferred vendor versus selling price descriptives

	N	Mean ($)	Std. deviation	Std. Error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
Amazon	73	10.08	8.56	1.00	8.08	12.07	1.29	46.77
iTunes	22	13.33	9.62	2.05	9.06	17.59	1.92	40.00
Google Play	6	5.03	3.65	1.49	1.20	8.86	2.05	12.00
Total	101	10.49	8.75	0.87	8.76	12.21	1.29	46.77

Table 5.7

Preferred vendor versus selling price ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	368.25	2.00	184.12	2.48	.09
Within groups	7282.11	98.00	74.31		
Total	7650.36	100.00			

Table 5.8

Preferred vendor versus selling price multiple comparisons

Preferred vendor		Mean difference	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
Amazon	*iTunes*	-3.25	2.10	0.272	-8.24	1.74
	Google Play	5.05	3.66	0.356	-3.67	13.76
iTunes	*Amazon*	3.25	2.10	0.272	-1.74	8.24
	Google Play	8.30	3.97	0.097	-1.15	17.74
Google Play	*Amazon*	-5.05	3.66	0.356	-13.76	3.67
	iTunes	-8.30	3.97	0.097	-17.74	1.15

Device versus interaction

Android users in general were less prone to engage with the exterior of the e-book. As seen in Tables 5.9 and 5.10, the mean external touch time of IOS users (M = 7919.72)was 35% higher than Android users (M = 5870.11). In external touches, as seen in Tables 5.11 and 5.12, the mean of IOS users (M = 7.49) was 62% higher than Android users (M = 4.61). The ANOVA test on this data yielded a high degree of statistical correlation (p = 0.03). The software differences between Android and IOS could be considered as factors in this. Android's diverse nature, representing a large range of lower-end mobile devices, ensures operation with multiple levels of performance.

Table 5.9

Mobile OS versus external touch time descriptives

	N	Mean (ms)	Std. deviation	Std. error	95% confidence iInterval for mean		Min	Max
					Lower Bound	Upper Bound		
IOS	86	7919.72	5017.44	541.04	6843.98	8995.46	707.00	24572.00
Android	46	5870.11	4838.97	713.47	4433.11	7307.10	0.00	17312.00
Total	132	7205.46	5033.82	438.14	6338.72	8072.20	0.00	24572.00

Table 5.10

Mobile OS versus external touch time ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	125900009.05	1	125900009.05	5.125	.03
Within groups	3193551373.76	130	24565779.80		
Total	3319451382.81	131			

Table 5.11

Mobile OS versus external touches descriptives

	N	Mean (touches)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower Bound	Upper Bound		
IOS	86	7.49	8.40	0.91	5.69	9.29	1.00	54.00
Android	46	4.61	3.97	0.59	3.43	5.79	0.00	15.00
Total	132	6.48	7.29	0.63	5.23	7.74	0.00	54.00

Table 5.12

Mobile OS versus external touches ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	248.52	1	248.52	4.817	.030
Within groups	6706.44	130	51.59		
Total	6954.97	131			

In regards to specific IOS devices, evidenced in Tables 5.13, 5.14 and 5.15, participants using iPads had touch times (M = 9107.47) 20% higher than those using iPhones (M = 7582.90). This analysis was statistically significant (p = 0.04). Given the factor of screen clarity in reading comfort (Noyes & Garland, 2003) elaborated upon in Section 2.3.4, a likely explanation for this is that larger screens, such as those on tablets like the iPad, invite longer, and perhaps more satisfying, periods of interaction.

Table 5.13

Mobile device versus external touch time descriptives

	N	Mean (ms)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
iPad	19	9107.47	4521.60	1037.33	6928.13	11286.82	2083.00	16430.00
iPhone	67	7582.90	5130.77	626.82	6331.40	8834.39	707.00	24572.00
Android	46	5870.11	4838.97	713.47	4433.11	7307.10	0.00	17312.00
Total	132	7205.46	5033.82	438.14	6338.72	8072.20	0.00	24572.00

Table 5.14

Mobile device versus external touch time ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	160305625.35	2	80152812.67	3.273	.04
Within groups	3159145757.46	129	24489502.00		
Total	3319451382.81	131			

Table 5.15

Mobile device versus external touch time multiple comparisons

Mobile device		Mean difference	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
iPad	iPhone	1524.58	1286.25	0.46	-1525.21	4574.37
	Android	3237.365*	1349.56	0.05	37.47	6437.26
iPhone	iPad	-1524.58	1286.25	0.46	-4574.37	1525.21
	Android	1712.79	947.57	0.17	-533.98	3959.55
Android	iPad	-3237.365*	1349.56	0.05	-6437.26	-37.47
	iPhone	-1712.79	947.57	0.17	-3959.55	533.98

As illustrated in Tables 5.16, 5.17 and 5.18, Differences in mean read times eluded statistical significance between devices (p = 0.08). Nevertheless, participants utilising iPads had the highest mean read time (M = 4749.26), followed by Android devices (M = 4474.46) and iPhones (M = 2699.85). As with the difference in touch time, the results invite an interpretation that larger screens instigate longer periods of reading. As aforementioned, greater resolution and screen quality can alleviate the mental strain of e-reading (Noyes & Garland, 2003), and it is possible that larger screens of some devices facilitated more easily readable text. User analytics did not distinguish between Android phones and tablets, as they did with iPhones and iPads, due to the overwhelming variety of devices designed to host the operating system. Given this, it is possible the average screen size or resolution of the Android devices was greater than that of the iPhones.

Table 5.16

Mobile device versus read time descriptives

	N	Mean (ms)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
iPad	19	4749.26	7835.75	1797.64	972.55	8525.97	976.00	35759.00
iPhone	67	2699.85	2101.87	256.78	2187.16	3212.54	451.00	9856.00
Android	46	4474.46	5889.72	868.39	2725.43	6223.49	892.00	25735.00
Total	132	3613.27	4842.79	421.51	2779.42	4447.11	451.00	35759.00

Table 5.17

Mobile device versus read time ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	114535098.11	2	57267549.06	2.50	.086
Within groups	2957757131.60	129	22928349.86		
Total	3072292229.72	131			

Table 5.18

Mobile device versus read time multiple comparisons

Mobile device		Mean difference	Std. error	Sig.	95% confidence nterval	
					Lower bound	Upper bound
iPad	iPhone	2049.41	1244.58	.230	-901.57	5000.39
	Android	274.81	1305.83	.976	-2821.42	3371.03
iPhone	iPad	-2049.41	1244.58	.230	-5000.39	901.57
	Android	-1774.61	916.87	.133	-3948.58	399.37
Android	iPad	-274.81	1305.83	.976	-3371.03	2821.42
	iPhone	1774.61	916.87	.133	-399.37	3948.58

Device versus selling price

Nevertheless, any discrepancies between IOS and Android did not seem to influence perceived value by a significant measure. As evident in Tables 5.19, 5.20 and 5.21, perceived value was for the most part consistent between participants utilising Android and IOS devices. iPhone users specified a mean selling price (M = 13.23) that was 7.8% higher than Android users (M = 10.22). However, one unexpected yet significant (p = 0.01) finding from the data was the low perceived value of iPad users (M = 6.14), 40% lower than Android users and 54% lower than those using iPhones. The reason for this is unclear and invites further study. Owing the iPad's popularity as an e-book platform (Torres, Johnson & Imhonde, 2014), one possible explanation is that iPad users are more likely to be frequent e-book customers, and are more discerning of price. As mentioned in Section 2.2.3, the endowment effect has a diminished effect on more experienced traders (List, 2004).

Table 5.19

Mobile device versus selling price descriptives

	N	Mean ($)	Std. deviation	Std. error	95% confidence interval for mean		Min	Max
					Lower bound	Upper bound		
iPad	19	6.14	4.56	1.05	3.94	8.34	1.79	17.71
iPhone	67	13.23	10.19	1.24	10.74	15.71	1.92	46.77
Android	46	10.22	9.22	1.36	7.49	12.96	1.29	43.53
Total	132	11.16	9.51	0.83	9.52	12.80	1.29	46.77

Table 5.20

Mobile device versus selling price ANOVA

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	805.82	2	402.91	4.704	.011
Within groups	11049.88	129	85.66		
Total	11855.70	131			

Table 5.21

Mobile device versus selling price multiple comparisons

Mobile device		Mean difference	Std. error	Sig.	95% confidence interval	
					Lower bound	Upper bound
iPad	iPhone	-7.09	2.41	.011	-12.79	-1.39
	Android	-4.09	2.52	.241	-10.07	1.90
iPhone	iPad	7.09	2.41	.011	1.39	12.79
	Android	3.00	1.77	.211	-1.20	7.21
Android	iPad	4.09	2.52	.241	-1.90	10.07
	iPhone	-3.00	1.77	.211	-7.21	1.20

5.6 Summary

The data answered the primary research question in such a way that partially confirmed the hypothesis: interactive audio feedback correlates with an intensification of the endowment effect. Only one of the sounds, sound two, a 640hz tone, was proven to demonstrate this trait. Nonetheless, there was conflicting data. An analysis of participants who registered no interaction compared with those who did inferred that the mere act of interacting with the e-book would correlate with doubled perceived value. However, the negative effect of exposure duration on perceived value was inconsistent with an established characteristic of the endowment effect noted in Section 2.23 (Lin, Chuang, Kao, & Kung). A possible explanation is the negative feelings reported by users regarding the usability of the instrument.

Much of the data intended to address the secondary research questions was inconclusive. No correlation was established between audio feedback and user interactivity, or user interactivity and perceived ownership. It should be noted however, the experiment's sample size was far smaller than the optimal amount deduced in Section 3.2. Outliers from the general trend can be accounted for in various ways. Given the uncontrolled environment in which the experiment was conducted, a participant's determination of selling price could have been affected by surroundings that were non-conducive to audio perception, for example, such as travelling on a train. A participant whose attention might only be in partial dedication to the experiment might also not have fully experienced the stimulation required to influence perceived value.

Serendipitous findings unrelated to the hypothesis and research question were made apparent in the demographic and user analytic data provided by participants registering for the complimentary raffle. For instance, IOS users had greater propensity to interact with the e-book than Android users. While iPad users interacted with the e-book for longer than iPhone users; iPhone users specified greater perceived value for the e-book.

In this chapter, the results were considered for their relevance to the hypothesis and research questions. In the following chapter, the study will be summarised in full. Implications of the results will be condensed and presented. Further avenues for research will also be highlighted.

6. Conclusion

6.1 Introduction

In this dissertation, the use of audio feedback in e-books was explored for its capacity to induce the illusion of tangibility, and thus increase user attachment. This study coincides with a time of uncertainty regarding the future of e-books, an industry of which has enjoyed a sustained period of considerable growth in the past decade (Tian & Martin, 2011). Strides in networked mobile technology have made digital media more portable, practical and profitable, and so while smartphones and tablet computers have boomed, ergonomic service-oriented e-readers like *Amazon's* Kindle have ushered in a new generation of e-readers that have learned from their past failures. While modern e-books come in a variety of models and types that are hard to generalise, the advancements in mobile technology have allowed the e-book industry to finally emerge in popular consciousness. However, the e-book industry has endured what some call a premature decline (Alter, 2015). Whereas other media industries, such as music and film, have benefitted from digitisation, e-books have struggled to position themselves as replacements for their analogue counterparts. Rather, a sentiment has persisted that e-books can never fully replace physical books (Staiger, 2014). E-books have an array of desirable benefits over print books; most notably, they can be compressed more easily for storage and they are more portable (Gibson & Gibb, 2011). Nevertheless, readers have indicated that there is a quantifiable value to tangibility that ensures their preference for print (Oestreicher-Singer & Sundararajan, 2004). It has become clearer that the importance of tangibility to perceptions of value, particularly in regards to e-books, is perhaps more significant than most will give credit.

Humans in general place significant faith in the reliability of their sensory instruments for understanding and interpreting their environment (Ernst & Bülthoff, 2004). One of the earliest developmental milestones of infants, object permanence, is the mental capacity to understand that objects outside of observation do not cease to exist (Murray, et al., 1979). On an instinctual level they are more concerned with the phenomenal world, the plane of existence perceivable with physical senses, demonstrated by a bias to value goods that they can touch and manipulate over those that are transient and

intangible (Raghubir & Srivastava, 2008). This is reflected in experiments of the endowment effect; an economic phenomenon that stipulates individuals tend to overvalue items in their possession (Kahneman et al., 1990). Humans seek to affirm such possession through sensory feedback (Peck & Childers, 2003). In retail, the simple act of touching and holding a product can increase a would be customers perceived ownership of that item, and consequently, increase the likelihood of a purchase (Peck & Shu, 2009).

However, human senses are fallible and prone to misconception through deliberate contradictions. These misconceptions are referred to as illusions, and they are brought about by exploiting the propensity of senses to bias each other. In one example, dubbed the parchment-skin illusion, when a certain sound was synchronised with an individual's touching of a surface it would alter that individual's haptic perception of that surface (Jousmäki & Hari, 1998). In other experiments, it has been shown that sustaining the sense of attachment that denotes the endowment effect is possible even when no physical contact takes place. Imagined touch, induced by sensory immersion, and relative to the vividness of that immersion, can sustain the same effects of true physical touch (Peck et al., 2013). In this experiment, the perception altering abilities of synchronised audio feedback, as evidenced in the parchment-skin illusion, were implemented to sustain such imagined touch. It was hypothesised that when audio was synchronised with a user's interaction with an e-book on a touchscreen, a positive effect on that user's attachment with the e-book would result. This was measured as an increased perceived value of that item. Four sounds were used for testing: a low pitch tone, a high pitch tone, a pink noise profile and a blue noise profile. A fifth sound represented silence, the control group.

6.2 Findings

The results from this experiment were promising. When synchronised to a user's interaction with an e-book on a touch screen, the high pitch tone, a 640Hz sound wave, was shown to correlate with a 50% increase in the perceived value of that e-book. The inherent implication is that audio feedback can in part compensate for haptic attachment to print books. A high pitch 640Hz sound effect, when used as audio feedback during e-

book interaction, demonstrated its capacity to intensify a user's attachment with that e-book.

Although the primary research question pertained to the influence of feedback sound, supplementary questions were posed to discern how the sound might affect the degree of e-book interaction engaged in by users, and to what extent such interaction might have affected the participant's attachment to that e-book. While no significant correlation was discerned in either case, one significant anomaly was noted; the negative correlation between duration of exposure and perceived value. In the literature on the endowment effect, as noted in Section 2.2.3, it is articulated that the intensity of attachment should have a positive relationship to exposure duration (Strahilevitz & Loewenstein, 1998). Contradicting expectations, the magnitude of the endowment effect represented in the results, was diminished with the duration of exposure. This was prevalent even in the control group. Three possible explanations were postulated to account for this.

Due to the paucity of literature in this field, it is speculated that this is a phenomenon unique to e-books in general. It could be that perceived ownership of any e-book is diminished with exposure. Any such exposure would invite and incubate a comparison with physical books in which e-books, as discussed in Section 2.3, would be considered unfavourably. This would still be incongruent with general consensus of the endowment effect in regards to physical goods, but it would relate to the larger trend of readers in general losing interest in the e-book market.

Although imagined touch can sustain the same endowment effect magnitude of physical touch, this is reliant on the vividness of the imagery (Peck et al., 2013). Such vividness might in fact be a fleeting sensation. In other words, the illusion of tangibility, one that imbues the e-book with a sense of ownership, is harder to sustain for longer periods. This could be a matter of desensitisation to the feedback, or rational disillusionment. In the case of the control group, which exhibited this trend despite having no feedback sound, the implication is that even without feedback a certain vividness of imagined

touch is established. This premise could be generalised to all e-books accessed from a touch screen device; a certain illusion of tangibility is inherent, although fleeting.

Given that the endowment effect can be eroded by negative emotional states (Lin, Chuang, Kao & Kung, 2006), it was speculated that user frustrations with the interface itself may be the chief contributor to this observation. It can be evidenced in Section 2.3.4 that backlit LCD screens are a source of discomfort to mobile device users when reading for sustained periods, offering a possible explanation (Siegenthaler et al., 2011). However, the correlation of such an effect would be observed on a larger timescale. Several user comments regarding irritation with the instrument interface were noted as a more plausible indicator of such grievances. Although the experiment was concerned with a specific aspect of e-book interactivity, in particular regard to the role of sound design, this observation supports the importance of holistic user experience design to the endowment effect. The subsequent implication is that regardless of interactive features, an inadequate user experience can undermine user attachment to digital objects. As a consequence, the inclusion of audio feedback, or interactive feedback of any sensory nature, should not be considered as a standalone feature but rather as a single element in a sensually immersive user experience.

6.3 Contributions

There are several industries in particular that can benefit from these findings. Foremost however, the conclusions drawn from this study have the most potent consequences for the future of e-books. E-books can benefit from interactive audio feedback on touch screen devices to cultivate a more intense feeling of ownership, attachment, and consequently, a sense of value. It is important to note the inference that when pursued at the expense of user experience, the endowment effect is diminished. E-book design should be considered from a holistic user experience perspective, one in which the role of interactivity is emphasised (Wilson & Landoni, 2002).

The online retail industries can also gain from these findings. By placing greater emphasis on the purchase experience, using audio feedback in interactive applications, vendors may heighten the endowment effect to increase perceived value of products and

subsequent purchase rates. In regards to mobile touch screen devices, retailers should consider how they can leverage interactive audio feedback. The endowment effect can give users a sense of attachment to objects at the point of sale, at which point they might not necessarily possess them in a legal sense, granted that a sense of tangibility is established (Shu & Peck, 2011).

The usage of audio feedback to influence endowment can apply across a wider spectrum of touch screen applications, a field in which the endowment effect has already received consideration (Brasel & Gips, 2014). The findings can prove valuable for implementation in contexts where sustained relationships with users are advantageous, for example, in interactive advertising. Another area of relevance is user interface design and evaluating the usefulness of audio feedback in interactive systems. For instance, much work has been done on the subject of *tangible user interfaces*, which promote more intuitive user interaction by incorporation of physical control and are epitomized by the modern pervasiveness of touch screens. Sensory feedback is critical to the operation of these systems (Oshaer, 2009).

With the growth of mobile games and the subsequent prevalence of touch screens as game controllers, there is also potential for game designers to that exploit the endowment effect. In developing interactive experiences for video games, game designers can take advantage of interactive audio feedback to foster a greater sense of attachment to virtual objects. Given the volume of microtransactions in this space, promoting a new kind of virtual materialism (Lehdonvirta, 2010), the possible implications of enhancing the endowment effect are attractive.

6.4 Further work

The data collected in this study has led to several potent conclusions. However further work must be done in order to affirm or otherwise account for the findings. With regards to limitations of the research, there are considerations to be made for subsequent studies. In order to affirm or challenge these findings it is recommended that subsequent studies build upon the methodology constructed for this research, and subject the hypothesis to a larger sample size and longitudinal testing. The conclusiveness of many

of the analyses in this experiment were ameliorated by the study's small sample size of 132 participants, given that an optimal pool was calculated to have been closer to 305. The majority of this sample, 85%, was recruited through online channels, posing a potential bias. Future studies may expand the diversity of their sample in regards to digital literacy.

As speculated in the hypothesis, it was shown that for a particular sound, e-book users expressed a heightened sense of perceived value. Although this can be interpreted as an intensification of the endowment effect, further study is needed to conclusively establish this relationship. To further understand the relationship between feedback sound and the endowment effect, any future study should account for both WTA and WTP. If the *Bookseller* application were designed for this purpose, the participants might first be asked to *buy* the e-book before given an opportunity to resell or trade it. Another consideration would be an option to keep the e-book, allowing it to be downloaded.

The anomaly in which perceived value had a negative relationship to participant exposure should be also be investigated, and to account for the three proposed alternative explanations, several approaches should be considered. The removal of the audio feedback variable would determine whether this is a phenomenon unique to e-books. A regular mainstream e-reader application could be utilised, rather than *Bookseller*, to account for user experience concerns. Such a study would compare a participant's exposure to an e-book with their specified WTA for that e-book. The study could also examine longer durations of exposure more reflective of a full reading experience.

Exploring the possibility that the illusion of tangibility diminishes in vividness with exposure requires a quantitative methodological approach much like those conducted to test the effect of ownership duration on endowment (Strahilvitz & Loewenstein, 1998). Such a study would be concerned with the degree to which participants feel their possession of the e-book is real, tangible or otherwise, quantified by a WTA/WTP divide, and compare it with duration of their exposure.

Other potential studies could explore the possibility of negative user experience impacting the endowment effect magnitude. A future study might also adopt a qualitative methodological approach to account for these attitudes and their impact on the endowment effect. If employing an application such as *Bookseller*, more extensive testing of the instrument before release would be recommended to improve functionality and reduce negative user experiences that that could undermine the endowment effect.

The implications of audio feedback for longer durations of exposure is also an avenue to be considered. This experiment has been concerned in large part with e-books as possessions. The instrument was designed for a short period of interaction; although 10 pages of content was provided for, on average, participants registered an examination time of about 10 seconds. Subsequent studies may examine how audio feedback can impact attachment for longer periods of examination. The effect of this feedback on the reading experience should yield interesting findings.

Another area to consider would be to repeat the experiment with another array of feedback sounds. Given that more realistic sounds, similar to sounds three and four, have been concluded to not significantly affect endowment, a replacement for the spectral width dimension should be considered. A repeat experiment might also pertain only to variations of frequency. Such an experiment might include the two sounds from this study with the most significant impacts, sounds one and two, in combination with two additional sounds of different frequencies. Additionally, the significance of high frequency tones in particular to the sense of tangibility and endowment is unclear and warrants exploration.

Further studies will also benefit from controlling for more variables. One of the issues of a research instrument hosted online that can be completed from anywhere is the lack of a controlled environment. As mentioned in the discussion, the peripheral environment of the participant cannot be taken into account. This might be addressed by requiring the procedure to take place in a laboratory setting. Another variable noted in the discussion was the individual NFT indexes of each participant. This index would account for the different degrees of reliance participants would ascribe to their haptic

perception. In a laboratory setting, this index could be measured and accounted for more accurately. The results from this analysis should yield some interesting conclusions.

6.5 Summary

When compared with print books, despite their practical advantages, e-books tend to be considered inferior for elusive hedonic reasons pertaining to tangibility. Howeverthrough proper implementation of interactive systems, at least at the point of sale, the research suggests it should be possible to establish a sense of ownership more akin to tangible print books. There is evidence to believe that e-books should eventually cease presenting themselves as simple digital editions and transcend the book metaphor. Developers should embrace the interactive affordances of digital media in order to lock step with the future of mobile storytelling.

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Appendix

A walkthrough of the Bookseller Application

When the webpage is first loaded, a participant is presented with a welcoming introductory passage as shown in Figure A.1. This page informs the participant about the basic nature of the study, including its purpose, the name of the researcher, and the institution. The participant is also informed of the approximate time that would be taken to complete their participation (one minute) and the incentive on offer for participating: an entry into a raffle for a $100USD gift card valid at the participant's retailer of choice. After being made aware that the enticement will be made available at the completion of their participation, the participant is prompted to press the *OK* button to proceed.

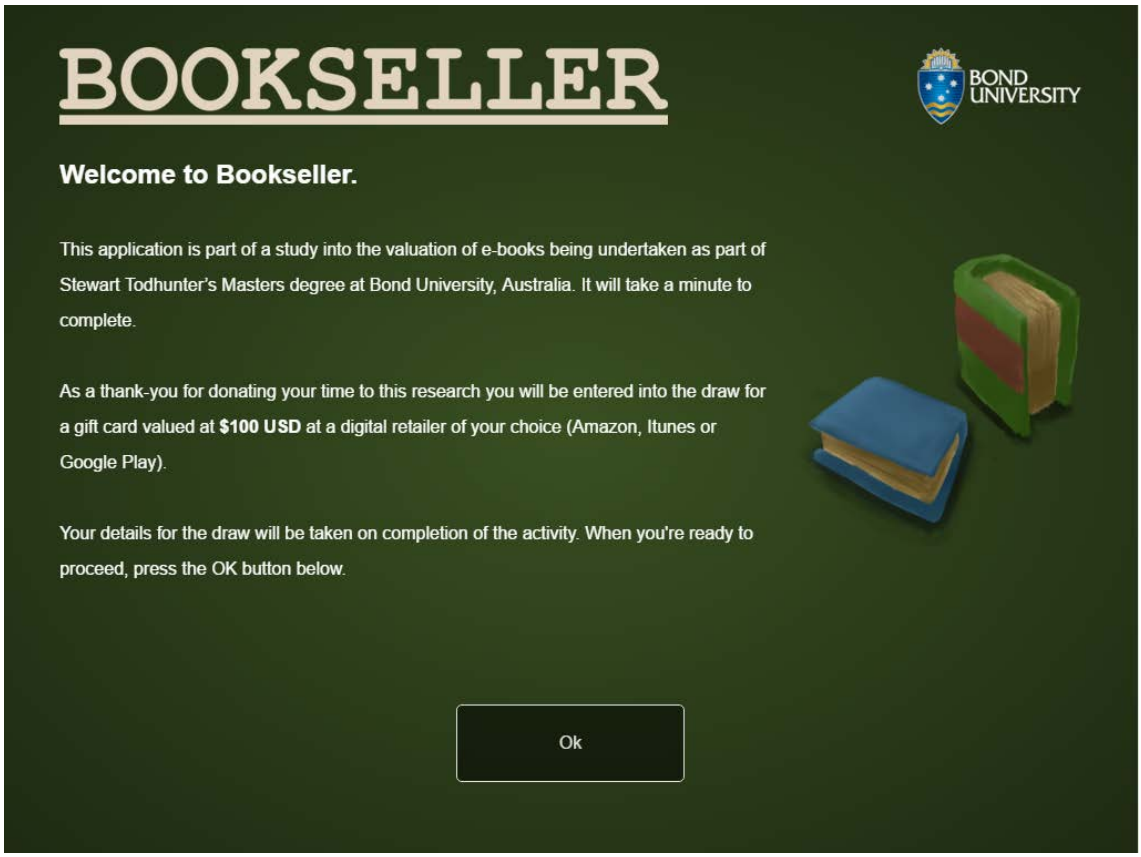

Figure A.1: The introductory message of Bookseller

At this point, if the participant is detected to not be using a touch screen mobile device they are presented with a screen the precludes them from participation. They are informed that they must be using such a device in order to complete their participation and hence receive their enticement. Alternatively, the participant is allowed an opportunity to refer the application to someone else, and earn an entry into the raffle that way.

If a mobile touch screen device is detected, the participant is presented with another screen as shown in Figure A.2. Here the participant is given a form to indicate their eligibility for the study and sign their consent. After checking the relevant boxes, the

participant is prompted to press the *begin* button. If both boxes are not checked, the application will not proceed.

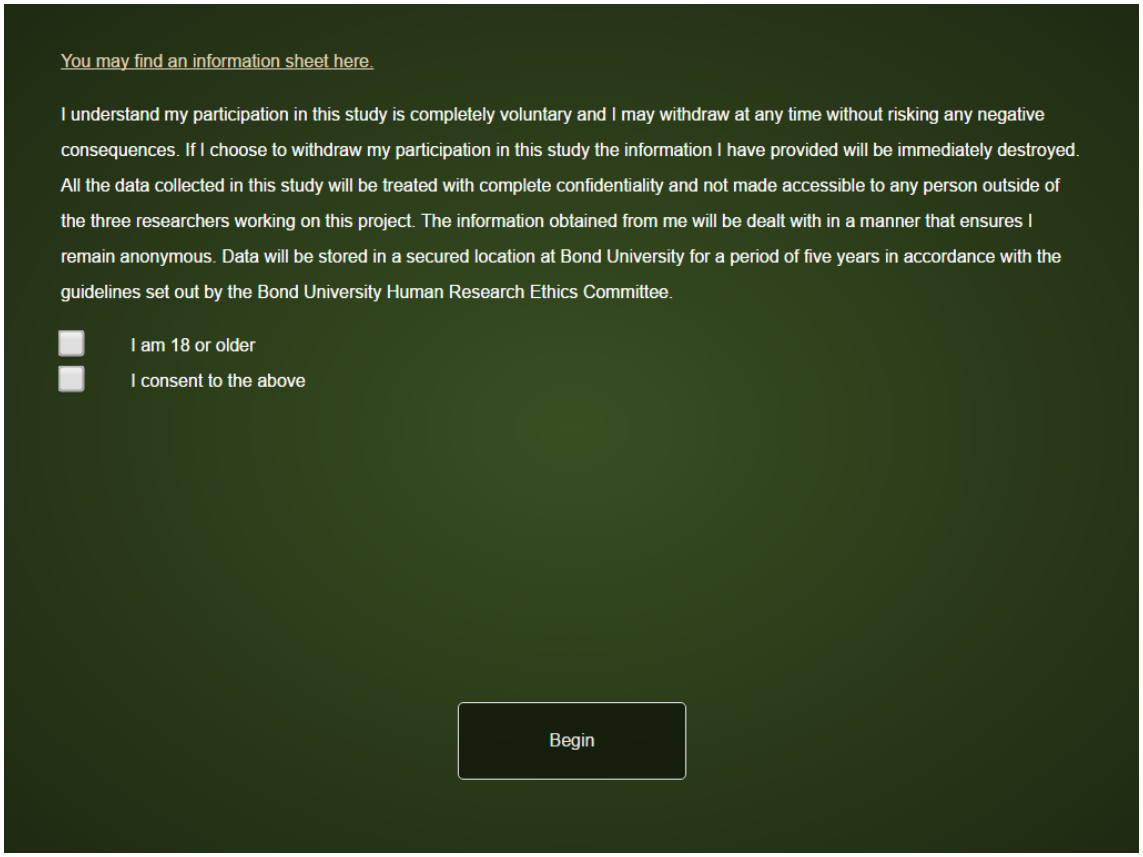

Figure A.2: Bookseller consent form

An alert box, as shown in Figure A.3, will appear on the participant's web browser, requesting that the participant make sure their volume is suitably adjusted.

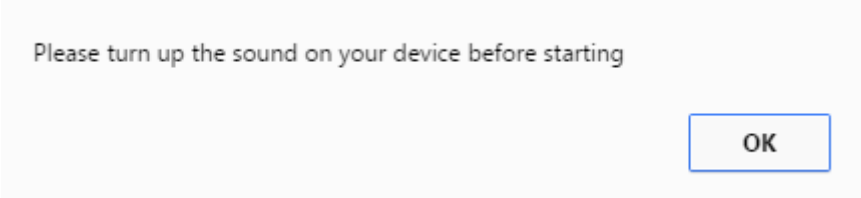

Figure A.3: Bookseller volume adjustment alert

Upon pressing *ok*, the next screen will load. This one illustrates "the story so far", supplying a fictional pretence adding context to the participation. The story, as presented in Figure A.4, refers to an electronic tablet that has been inherited from an aunt. One of the e-books is resalable, which would free up space on the tablet and make it usable again. As such, the participant is assigned the task of appraising the book and indicating a suitable price for resale. To begin, the participant is prompted to press the *OK* button.

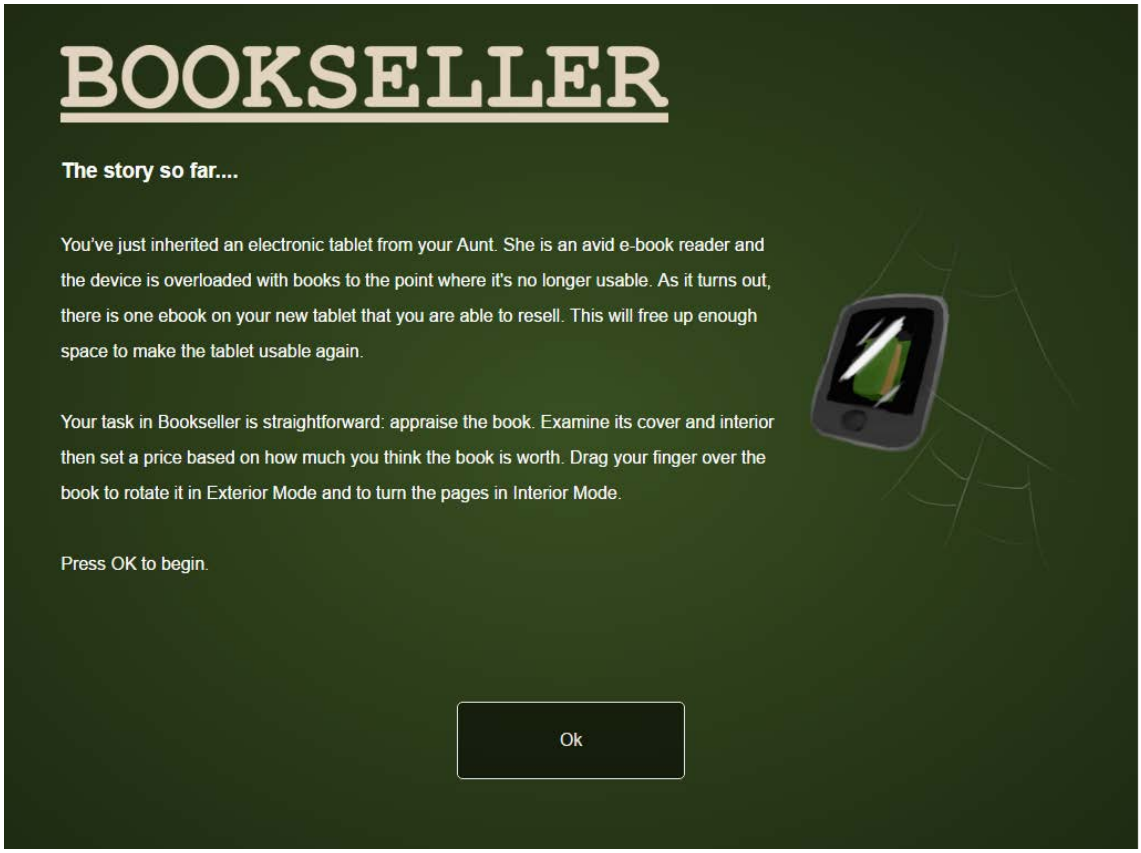

Figure A.4: The pretence script of Bookseller

The next screen initiates the e-reader interface of Bookseller. Immediately evident to the participant is a 3D representation of the e-book as a hardcover physical book, embellished by the title of the book, *Summer Days*, in addition to some generic cover

markings. This screen is illustrated in Figure A.5. The participant will discover that by touching the book, they can rotate it in 3D space. For each participant, one of 4 possible sounds or silence will be assigned as interactive audio feedback when touching the book. A panel on the side of the screen indicates that the current *external* mode is one of three *steps*.

Figure A.5: Exterior mode in Bookseller

The next step is designated by the *internal* button. When the participant presses this, the 3D book is replaced by an interface more recognisable as an e-reader, as shown in Figure A.6. The content of the e-book is displayed here in a page-by-page layout, through which the participant can navigate by dragging the pages from either side.

Figure A.6: Interior mode in Bookseller

The feedback sound from the external mode continues here whenever the participant's finger makes contact with the pages. After reading as much of the book as desired, within the 10 pages available, the participant will inevitably switch to step 3, captioned as *sell*. Upon commencing step 3, the book disappears completely and is replaced by a simple slider interface and confirmation button. This screen is shown in Figure A.7. The participant is prompted to slide the price to a reasonable number, before pressing the prevalent *sell* button.

Figure A.7: Selling mode in Bookseller

At this point, the participation is effectively concluded and the participant's data is saved to the server. Another screen, presented in Figure A.8, is presented to the participant, thanking them for their time and inviting them to participate in the advertised raffle. To this end, the participant is asked to specify their email address, their age range, their preferred vendor for the gift card, and whether they would appreciate receiving a *debriefing* of the study by email upon its conclusion. A facility for participants to express any other comments they may have regarding the study is also provided. A final *OK* button is presented for participants to submit their enrolment in the raffle. Otherwise, a participant may simply wish not to record their details and abstain.

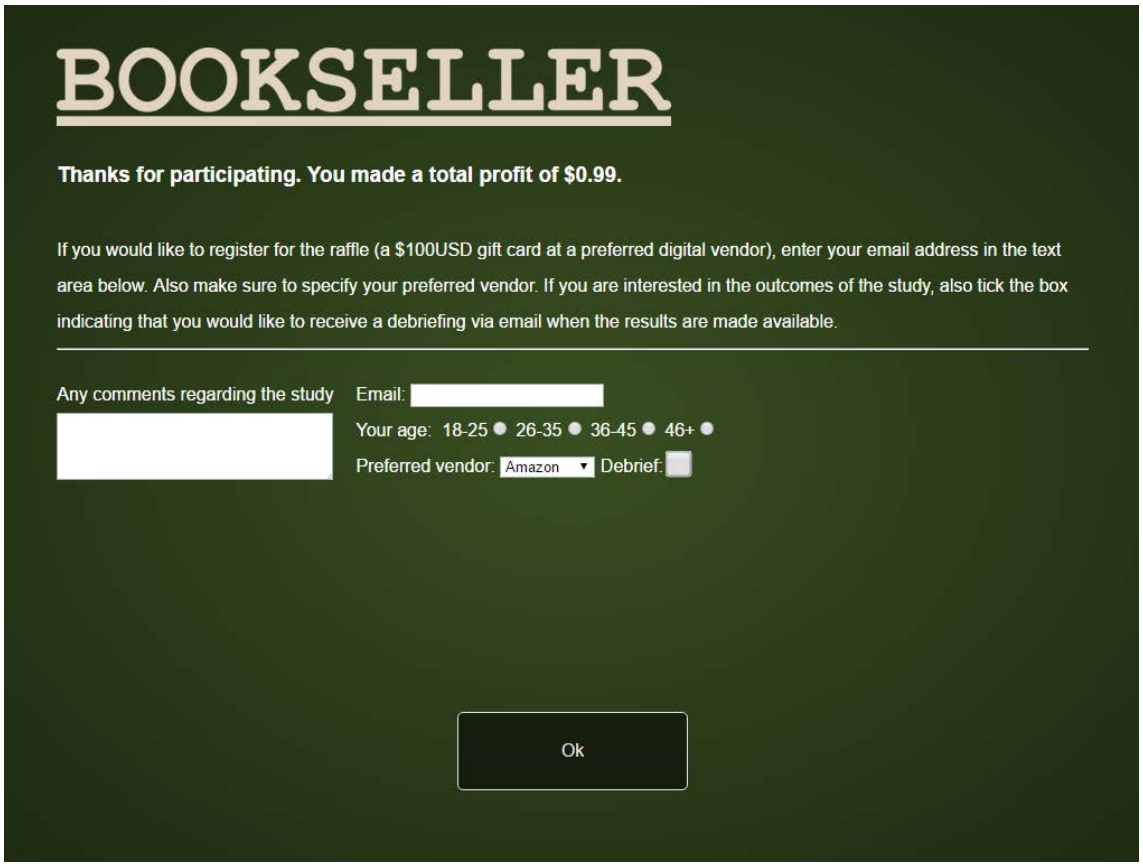

Figure A.8: The conclusion of Bookseller

Having submitted their involvement in the raffle, the final screen (shown in Figure A.9) of Bookseller offers the participant an opportunity to gain extra raffle entries by referring other participant to the study. Several common social media platforms are provided for this end.

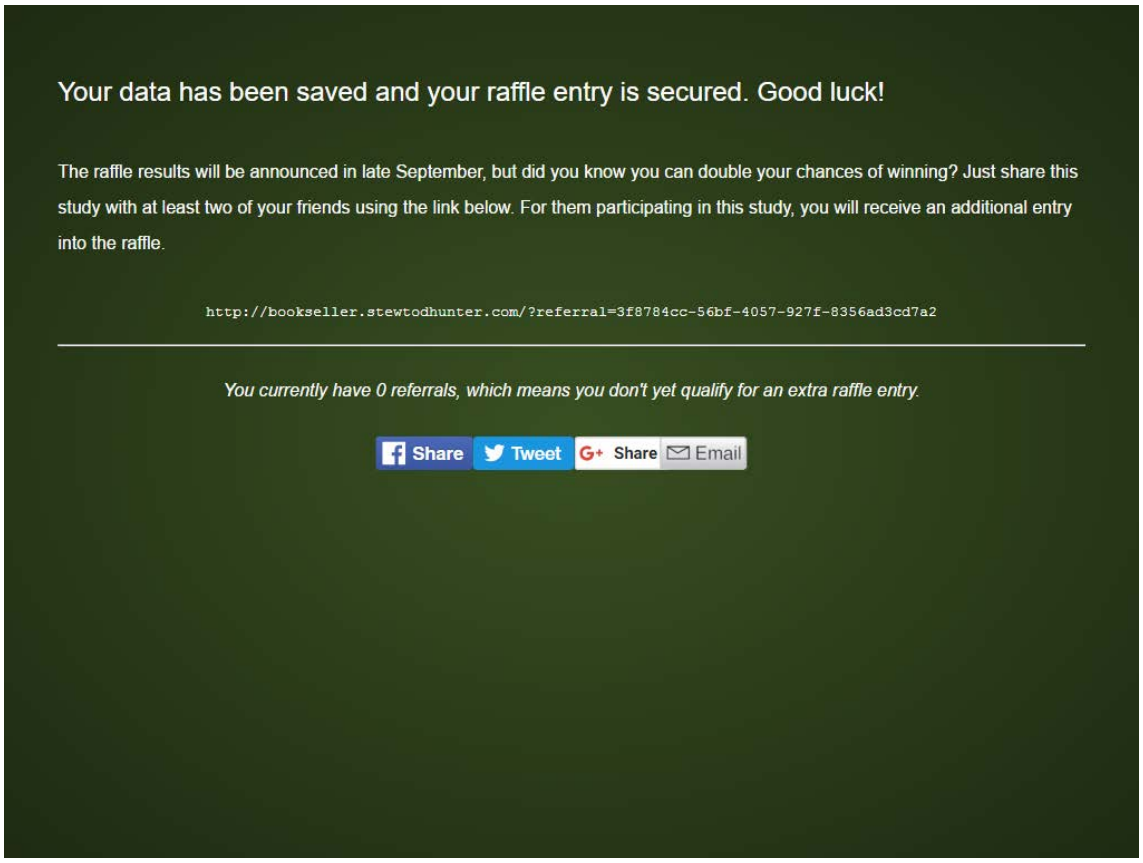

Figure A.9: The confirmation and referral screen of Bookseller