Modelling 3D Product Visualisation for the Online Retailer

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Abstract

This research aims to explain the process that previous researchers have discussed concerning the consumer virtual experience, using three-dimensional (3D) product visualisations, within online retailers. In addition, this research aims to identify the main advantages of using 3D product visualisation in comparison to two-dimensional (2D) static pictures within online retailers. Moreover, using the online Stimulus-Organism-Responses (S-O-R) paradigm, this research aims to model the effect of 3D product visualisation on consumers' perception and responses towards the online retailer environment. Given that the appearance of the notion of telepresence or presence and their implications on the online retailer, many scholars attempt to build and develop models that can suit these notions online. However, this thesis argues that the notion of 3D telepresence is not the proper terminology to be used within the online retail context and therefore, this research raises the following question "how do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?"

The effects of 3D product visualisation and 2D static pictures have been raised during the past decade to determine which is better for the online consumers. Marketers and information system scholars started wondering about the best device that can generate hedonic and utilitarian values for the consumers. To investigate the main impact of 3D product visualisation and 2D static pictures on hedonic and utilitarian values, this research raises the following questions:
How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailers' website? How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailers' website?

This thesis, based on the previous literature in interactivity and vividness, narrowed down the 3D authenticity antecedents to the control and animated colour constructs. Moreover, to determine the effect of the progressive levels of control and animated colour constructs on the 3D authenticity construct, it raises the following research question: How do different levels of 3D control and animated colours influence 3D authenticity?

To determine the effects of the progressive levels of 3D hedonic and utilitarian values on behavioural intention construct, this thesis raises the following research question: How do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?

Based on the online S-O-R framework, previous studies investigate the impact of the whole website e-retail environment (many stimuli) on consumers' responses. Yet, this is the first study that is using one stimulus, namely 3D laptop product visualisation to investigate its impacts on consumers' perceptions and responses using the online S-O-R paradigm. Therefore, this thesis raises the following research question:
How do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?

The results reveal significant differences between 3D telepresence and 3D authenticity constructs. 3D telepresence involves an illusion or a sense of being transported to another place, whereas 3D authenticity refers to the ability to imagine a virtual object as real. The 3D authenticity construct is more significant in simulating an online retailer's products. The proposed online S-O-R conceptual model achieves acceptable fit and the hypothesised paths are all valid.

This research adds to the marketing literature the notion of 3D authenticity and contributes a valid scale to measure that new variable. Moreover, it is the first study that connects and uses the antecedents of 3D authenticity (S), control and animated colours, to investigate their impact on 3D authenticity, hedonic and utilitarian values (O), and the impact of the Organism constructs (O) on behavioural intention (R). Furthermore, the final framework considers the first framework that has studied the impact of one stimulus using the online S-O-R framework on an electronic retailer website environment. Indeed, to the best of the researcher's knowledge, this is the first study that uses a UK sample to investigate the effects of an authentic 3D product visualisation in an electronic e-retailing industry (i.e., laptops).

Contents

LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
AGFI	Adjusted Goodness-of-Fit
AMOS	Analysis of Moment Structure
ANOVA	Analysis of Variance
AR	Augmented Reality
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CR	Critical Ratio
D^2	Mahalanobis Distance
DF	Degree of Freedom
df	Degrees of Freedom
EFA	Exploratory Factor Analysis
GFI	Goodness-of-Fit Index
HCI	Human Computer Interaction
IFI	Incremental Fit Index
IIT	Image Interactivity Technology
IT	Information Technology
IVR	Immersive Virtual Reality
KMO	Kaiser-Mayer-Olkin
ML	Maximum Likelihood
NFI	Normed Fit Index
NIVR	Non-Immersive Virtual Reality
PAD	Pleasure-Arousal-Dominance
r	Pearson's Correlation
R^2	Coefficient of Determination
RFI	Relative Fit Index
RM	Relationship Marketing
RMSEA	Root Mean Square Error of Approximation
SD	Standard Deviation
SE	Standard Error
SEM	Structural Equation Modelling

S-O-R	Stimulus-Organism-Response
SPSS	Statistical Package for Social Science
SRAVE	Squared Roots of Average Variance Extracted
TAM	Technology Acceptance Model
TLI	Tucker-Lewis *Index*
TRA	Theory of Reasoned Action
VE	Virtual Experience
VoIP	Voice over Internet Protocol
VR	Virtual Reality
α	Coefficient Alpha
β	Standardised Regression Weight
λ	The Standardised Factor Loadings
χ^2	Chi Square
χ^2/df	Normed Chi-Square

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Dedication

This thesis is dedicated to my wonderful parents, Salah and Jamila, my five lovely sisters, four fabulous brothers, and my dearly departed grandfather, Abdul-Qadir - with love and gratitude.

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2) Algharabat, R. and Dennis, C. (2009a) ‘The Effects of Progressive Levels of 3D Authenticity Antecedents and Consequences on Consumers’ Virtual Experience’, *Brunel Business School Archive (Bura).*
3) Algharabat, R. and Dennis, C. (2009a) ‘Using 3D product visualisation to tap consumers’ experience with online retailers: From telepresence to authenticity’, *Brunel Business School Archive (Bura).*
4) Algharabat, R. and Dennis, C. (2009b) ‘Modelling 3D Product Visualisation for Online Retail Atmospherics’, *Brunel Business School (Bura).*
5) Algharabat, R. and Dennis, C. (2009a) ‘3D Product Authenticity Model for Online Retail: An Invariance Analysis’, *Brunel Business School Archive (Bura).*

Conferences

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2) Algharabat, R. and Dennis, C. (2010) '3D Product Authenticity Model for Online Retail: An Invariance Analysis', *International Journal Business Science and Applied Management*, 5 (3) pp. 14-30.

Under Review Journal Papers

1) Algharabat, R. and Dennis, C. (2010) 'Using Authentic 3D Product Visualisation to tap consumers' experience with online retailers: From telepresence to authenticity', *Journal of Marketing Management* (second round).
2) Algharabat, R. and Dennis, C. (2010) 'Modelling 3D Product Visualisation for Online Retail Atmospherics', *Journal of Retailing*.
3) Algharabat, R. and Dennis, C. (2010) 'Telepresence and/ or Authenticity for Online retailer: The Effects of 3D product Visualisation on Consumers' Virtual Experience', *Journal of Marketing*.
4) Algharabat, R. and Dennis, C. (2010) 'The Effects of 3D Telepresence and 3D Authenticity on the Online Retailer', *Journal of Interactive Marketing*
5) Algharabat, R. and Dennis, C. (2010) 'Modelling the Impact of 3D Authenticity and 3D Telepresence on Behavioural Intention for an Electrical Online Retailer', *European Retail Research*.

Author's Declaration

I, Raed S. Algharabat, declare that the ideas, research work, analyses and conclusions reported in my PhD thesis *Modelling 3D product visualisation for the online retailer* are entirely my effort, except where otherwise acknowledged. Also, I certify that this thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.

1 CHAPTER ONE INTRODUCTION

1.1 INTRODUCTION

Chapter One introduces the scope of this thesis. Section 1.2 presents the research background. Section 1.3 specifies the research problems. Section 1.4 explains the research aims. Section 1.5 explains the justifications for carrying out this research. Section 1.6 discusses the methodology that has been followed to answer the research questions and to test the proposed hypotheses. Section 1.7 describes the significance of this research. Section 1.8 explains the overall structure of the thesis.

1.2 RESEARCH BACKGROUND

The last two decades have witnessed an acceleration of the development of technological devices. New devices such, as three dimensional (3D) product visualisations, enable e-retailers and marketers to create and manipulate virtual reality (VR) environments to simulate fictitious or real life products. Steuer (1992, p.78) posits that virtual reality (VR) is "*a real or simulated environment in which a perceiver experiences telepresence*". In contrast, virtual experience (VE) derives from VR and can be defined as "*psychological and emotional states that consumers undergo while interacting with a 3D environment*" (Li, Daugherty, and Biocca, 2001, p. 14). A 3D product visualisation technology not only enables online retailers to apply and empirically test the significant effects of employing the 3D product visualisation within their websites, but also often enables consumers to interact with products, enriches their learning processes, creates a sense of being in a simulated real world, and boosts their abilities to surpass, psychologically, an actual experience with the offline products (Li et al., 2001). Indeed, the 3D technology enables consumers to live a fictitious life while navigating virtual models. Hence, based on this technology, marketers have build models that might explain how consumers experience the illustrated 3D products in retailers' websites. In particular, marketers focused on the notions of telepresence or presence to surpass consumers' virtual experience with the 3D product visualisation. Despite widespread discussions and various definitions of the VE, this thesis notices that previous scholars, within the online retail context, consider the notions of 3D telepresence or presence as virtual substitutes for actual experience with the products. However, the telepresence and presence constructs are not necessarily wholly appropriate concepts for marketers since they represent a process of being mentally transported into other areas, a state of illusion or being immersed into an illusion environment (Lee, 2004). Such notions may not be particularly helpful for marketers and website designers who are concerned with 3D product visualisation of real products.

1.3 RESEARCH PROBLEMS

Given that the appearance of the notion of telepresence or presence and their implications on the online retailer, many scholars attempt to build and develop models that can suit these notions online. However, this thesis argues that the notion of 3D telepresence is not the proper terminology to be used within the online retail context and therefore, this research raises the following question:

> RQ1) How do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?

The effects of 3D product visualisation and 2D (two-dimensional) static pictures have been raised during the past decade to determine which is better for the online consumers. Marketers and information system scholars started wondering about the best device that can generate hedonic and utilitarian values for the consumers. To investigate the main impact of 3D product visualisation and 2D static pictures on hedonic and utilitarian values, this research raises the following questions:

> RQ2) How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailers' website?

RQ3) How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailers' website?

This thesis, based on the previous literature in interactivity and vividness, narrowed down the 3D authenticity antecedents to the control and animated colour constructs. Moreover, to determine the effect of the progressive levels of control and animated colour constructs on the 3D authenticity construct, it raises the following research question:

RQ4) How do different levels of 3D control and animated colours influence 3D authenticity?

Moreover, to determine the effects of the progressive levels of 3D hedonic and utilitarian values on behavioural intention construct, this thesis raises the following research question:

RQ5) How do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?

Based on the online Stimulus-Organism-Responses (S-O-R) framework, scholars (e.g., Eroglu, Machleit, Davis, 2001; 2003; Richard 2005; Sautter, Hyman, Lukosius, 2004) investigate the effect of the overall online store environment, especially atmospheric qualities (S), on shoppers' emotional and cognitive states (O), which then affect their shopping outcomes (R). With respect to the previous studies on this area, a few of them have tested the influence of one stimulus alone. Previous studies investigate the impact of the whole environment (using many stimuli) on consumers' responses. Yet, this is the first study that is using one stimulus, namely 3D laptop product visualisation to investigate its impacts on consumers' perceptions and responses using the online S-O-R paradigm. Moreover, only two studies (Manganari, Siomkos, Vrechopoulos, 2009; Sautter *et al*., 2004) have theoretically investigated the effects of online store atmosphere on consumer behaviour. Unfortunately, both Sautter *et al*. (2004) and Manganari *et al.'s*. (2009) models were not empirically tested and there is no clear cut opinion about the nature of the proposed relations or how they might impact each other. Therefore, this thesis raises the following research question:

> RQ6) How do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?

1.4 RESEARCH AIMS

This research aims to explain the process that previous researchers have discussed concerning the consumer virtual experience, using 3D product visualisations, within online retailers. In addition, this research aims to identify the main advantages of using 3D product visualisation in comparison to 2D static pictures within online retailers. Finally, using the online S-O-R paradigm, this research aims to model the effect of 3D product visualisation on consumers' perception and responses towards the online retailer environment.

1.4.1 Research Objectives

(i) Bridging the gaps in the virtual experience research by determining the main differences between the 3D telepresence construct and the notion of 3D authenticity, and introducing a valid scale to measure 3D authenticity within the context of the online retailer.

(ii) Demonstrating the main differences (if there are any) between 3D product visualisation and 2D static pictures in generating hedonic and utilitarian values for users.

(iii) Discovering the effect of the progressive levels of control and animated colour constructs in creating the notion of 3D authenticity. Moreover, understanding how the progressive levels of 3D hedonic and utilitarian values impact the behavioural intention.

(iv) Extending the online S-O-R model by adding the antecedents of 3D authenticity to the model, and by testing how the addition of 3D authenticity, hedonic and utilitarian values might influence consumers' responses.

1.5 JUSTIFICATIONS FOR THIS RESEARCH

Previous research on virtual experience has been carried out for the virtual reality environment, which allows users to live a fictitious life. Previous research relies on using the immersive technological devices, such as goggles, head-mounted visors, data-gloves, joysticks and head trackers. Based on the previous technology devices, marketers within the non-immersive virtual reality environment have used the same terminologies to describe users' virtual experiences. Marketers have focused on the notions of telepresence or presence to surpass consumers' experience with the actual high street environment. Notwithstanding, using these notions make the virtual experience something undesirable, because such notions consider different meaning, such as transportation to other places, illusion or immersion. Moreover, using such notions would not enable marketers to measure users' virtual experiences properly. Despite widespread discussions and various definitions of 3D telepresence, to the best of the author's knowledge, no existing scales tap the concept of using virtual environment (in a non-immersive VR) to reflect consumers' experience. To help users to achieve a virtual experience, marketers should use "authentic-objects" in which users can interact with objects they can find in real life aspects such as clothing or electricals. The author believes that the previous scales would not help marketers to measure 3D online products as real representatives of the offline products. Moreover, being the first study to identify the main antecedents of the 3D authenticity construct, the research for this thesis manipulated the control and animated colours to determine their impact on the 3D authenticity construct. To bridge the gaps in the previous literature, this thesis investigates the main differences between hedonic and utilitarian values that 3D and 2D product visualisations often offer for consumers. Furthermore, to bridge the gaps in the previous online S-O-R framework and to create a model that suits the context of 3D product visualisation, this thesis focused on using a single stimulus, namely, 3D product visualisation to model the effect of the stimulus on the organism, and the impact of the organism on responses.

1.6 METHODOLOGY

The current research uses the two paradigms of positivism and idealism. First, this research starts with an idealism paradigm, focusing on a qualitative method (i.e., use of focus groups) to explore how using 3D product visualisation may provide participants with a sense of perceived authenticity, i.e., what elements make participants feel and think that using 3D product visualisation creates a simulated product experience that is very close to the experience they may have when visiting offline retailers? Second, the current study uses a positivist paradigm (i.e., a quantitative method) to test the proposed hypotheses and their causal relationships.

1.6.1 Stimuli

This research designs a hypothetical retailer's website with two stimuli. The first stimulus was illustrated on 3D product visualisation sites that allowed participants to view the focal product, laptops, from different angles; they also can rotate the products and zoom in or out. The 3D stimulus is intended to help consumers to imagine the product in appropriate and relevant ways, and thus enhance their virtual experiences (Li *et al*., 2001). The second stimulus was illustrated on 2D static sites, where participants could only see product images of laptops without being able to change or modify them. Choosing two stimuli in one retailer's website was used to answer the research questions regarding the main influences of 3D product visualisations and 2D static pictures on consumers' perceptions (i.e., hedonic and utilitarian values).

1.6.2 Experimental Procedure

To eliminate individual differences, this thesis employed a within-subjects design for the first four stages. Each subject, therefore, represents his or her own control (Greene and d'Oliveira, 1999). This design increases the statistical power of the experiment because it requires fewer subjects than for a between-subjects design. Moreover, it helps reduce error variance, which is associated with individual differences. Furthermore, this design helps reduce costs because it takes several observations from the same subject (Greenwald, 1976; Keppel and Wickens, 2004).

1.6.3 Interface Design

This thesis designed four 3D flashes (sites) for the 3D product visualisations. The first contained a laptop where participants could zoom in or out, rotate, change the colour and obtain information about its features and attributes. The second flash featured a similar laptop, but only limited information about its external appearance was available (i.e., participants could only close and open the laptop). In the third flash, they could still zoom and rotate, but not change the laptop colour. Finally, participants could do nothing with the laptop in the fourth flash, which could be simply rotated on its own. These 3D sites, particularly the flash that contained information, distinguished the current research from previous studies that have reported the significant role of 3D in enhancing fun and enjoyment values more than utilitarian values (e.g., Fiore, Jin, Kim, 2005b; Kim and Forsythe, 2007; Lee, Fiore, Kim, 2006; Schlosser, 2003). This study also includes further websites using 2D static pictures to present information about the laptops' features, attributes, functions and external appearances. Moreover, the 2D site enables users to see the laptops with different colours.

1.6.4 Experimental Design

The designed websites (in all the stages) were not previously known to the users, nor did users have any knowledge of the fictitious brands on the sites. Thus, this research eliminated any impact of previous experiences or attitudes (Fiore, Kim, Lee, 2005a). The designed sites offer a wide variety of laptops, similar to those that many college-aged men and women currently use. Therefore, the created sites provide a suitable context for the present sample.

This study consisted of five separate stages. In the first stage, participants were asked questions about the authenticity and telepresence of the simulation of the 3D laptops. The second stage demonstrated the difference between the indirect experience (i.e., using 2D static pictures) and the virtual experience (3D product visualisations) in providing more information and fun to consumers. Stage three used a two-way repeated measures ANOVA to determine the effects of the progressive levels of the antecedents (control and animated colours) on 3D authenticity. The fourth stage used a two-way repeated measures ANOVA to determine the effects of the progressive levels of 3D authenticity consequences (hedonic and utilitarian value) on the dependent variable (i.e., behavioural intention). Finally, in the fifth stage, this research developed a conceptual framework, based on the online S-O-R framework, and tested the relationships in the proposed model using the high levels of 3D authenticity antecedents, consequences, and behavioural intention. The impact of control and animated colours on 3D authenticity; and the impact of 3D authenticity, hedonic and utilitarian values on behavioural intention were investigated.

1.7 STATEMENT OF SIGNIFICANCE

This thesis makes a significant contribution to the e-retailing literature by introducing a new and valid construct, namely the 3D authenticity. The emergence of the notion of 3D authenticity makes it easier for marketers (e-retailers) to use and apply this notion within the online retailer context.

This research makes an important contribution to the online atmospheric literature by providing a rich explanation of how authenticity of the 3D virtual models adds more information and fun, and enhances consumers' responses towards the online retailer. The main purpose of using the S-O-R framework is to fill the gaps in the previous literature that studied the impact of the online store atmosphere. With regard to the previous studies on this area, few have tested the influence of one stimulus alone. Previous studies investigated the impact of the whole environment (using many stimuli) on consumers' responses. To the best of the researcher's knowledge, this research is the first study in the UK that uses a UK sample to investigate the effects of 3D product visualisation on consumers' perceptions and responses using the online S-O-R paradigm. This study focuses on the impact of 3D product visualisation antecedents (S); control and animated colours on consumers' perception process (O), i.e., 3D authenticity, hedonic and utilitarian values; and the impact of consumers' perception on their responses (R), i.e., behavioural intention. In support of the previous theoretical studies, this research finds that when using the online S-O-R framework it is very important to focus on the stimulus part (S), i.e., control and animated colours. This study empirically finds control and animated colours have positive and direct relationships with 3D authenticity. 3D authenticity has positive and direct effects on hedonic and utilitarian values, and, finally, 3D authenticity, hedonic and utilitarian values have positive and direct effects on behavioural intention. The investigation of the S-O-R framework in this thesis has provided us with a further understanding of the relationship development, which is useful for both academics and practitioners.

The area of this study is unique as previous research examined 3D product visualisation of apparel products (Fiore *et al.*, 2005a; Fiore *et al.*, 2005b; Kim, Fiore, Lee, 2007; Lee *et al.*, 2006; Li *et al.*, 2003), watches and bedding (Lie *et al.*, 2003), and a desktop computer and computer table (Suh and Lee, 2005; Suh and Chang, 2006). This study explored a new scope of 3D product visualisation and empirically tested the effects of using 3D product visualisation of laptops on behavioural intention. The design of this study is original in using websites that have progressive levels of control, animated colours, hedonic and utilitarian values. This is the first model that connects 3D product visualisation antecedents (control and animated colours), and the impact of the focal construct, authenticity of the 3D product visualisation, and its consequences (hedonic and utilitarian values) on behavioural intention. Previous research has either empirically tested the progressive levels of 3D antecedents on telepresence or realism (e.g., Klein, 2003), or it has investigated the relationships between the 3D telepresence and other constructs (e.g., attitude and product knowledge, as Coyle and Thorson, 2001). In turn, this research investigates the effects of progressive levels of control and animated colours on 3D authenticity, and the effects of the progressive levels of hedonic and utilitarian on behavioural intention. As a result, this research considers the high level of each construct and investigates the effects of Stimulus on Organism and the effect of the Organism on consumers' Responses, using the online S-O-R framework.

1.8 OUTLINE OF THE THESIS

Chapter Two provides an explanation about the historical development of the notion of telepresence in the immersive VR, the applications of telepresence in a non-immersive VR and 3D telepresence antecedences and consequences. The notion of 3D authenticity, its definition and its antecedents and consequences (to suit online retail consumers when using 3D product visualisation) are discussed.

Chapter Three explains the Stimulus-Organism-Responses (S-O-R) framework theory in the offline and online retail contexts. The main gaps in the previous online S-O-R frameworks or the extended frameworks are discussed. Moreover, this thesis proposes a new combination of the S-O-R framework to model using the 3D product visualisation in the online retail site.

Chapter Four explains the conceptual framework. Specifically, this chapter hypothesises the effects of different levels of the 3D antecedents on the notion of 3D authenticity. Moreover, the impact of 3D authenticity consequences on behavioural intention is also hypothesised. Using the Stimulus-Organism-Responses (S-O-R) framework, this thesis discusses the main constructs in the stimulus part (S); control and animated colours and the main constructs in the organism part (O); 3D authenticity, hedonic and utilitarian values and the impact of the organism part on the responses part (R); behavioural intention.

To answer the research questions and to test the proposed hypotheses, Chapter Five presents the main methodological foundations and the research design of the current thesis. Moreover, the chapter discusses the main experimental methods used in each stage of this research for data collection, the research instrument and scales, the pilot study results, the sample, questionnaire design, software packages and statistical techniques used in this research.

Chapter Six presents the main results of this thesis which include: the steps of preparing, editing, coding and screening the data, normality, linearity, multicollinearity and outliers of the 3D and 2D sites data. Exploratory factor analysis using the maximum likelihood extraction method and the direct oblimn rotation method for the 3D sites are also presented. A series of one-way repeated measure ANOVAs is reported, followed by two-way repeated measures ANOVA. Moreover, the chapter demonstrates the structural equation modelling (SEM) results, in which the measurement and structural models were tested and empirically reported. Finally, the invariance analysis results between genders, e-shopping experience, education levels, study backgrounds and age are explained.

Chapter Seven discusses the research results, research questions, managerial implications, theoretical implication and methodological implications. Research limitations and further research areas are also identified.

1.9 SUMMARY

This introductory chapter clarifies the need to establish a measurement scale for 3D authenticity, after justifying the emergent need to have a notion that might be used to replace that of 3D telepresence, which indicates a transportation state or an illusion state. The research aims and questions have been drawn up in this chapter. In addition, research novelty and contribution have been illustrated as well. Finally, the research outlines and chapters to be explained are discussed. The next chapter discusses the published research in this area.

2 CHAPTER TWO: TELEPRESENCE/PRESENCE HISTORICAL DEVELOPMENT, CONCEPTS, AND DEFINITIONS

2.1 INTRODUCTION

The emergence of a new technology, such as three dimensional (3D), enhances customers' virtual reality (VR). Virtual experience derives from VR and often helps consumers to imagine psychologically and emotionally how a product might look. A 3D technology enables both marketers and consumers to live a fictitious life while navigating a 3D product visualisation. Hence, marketers, based on this technology, build models that might explain how consumers' experience the illustrated product in the 3D.

During the last two decades, notions of presence or telepresence have clearly appeared in many fields such as information technology (IT), communication, business, and psychology. Since that time there has been a considerable debate about defining, conceptualising and determining the antecedents of these notions. Even though the origin of these notions came from novels and Gibsonian theories, the early scholars have defined and conceptualised these notions based on the immersive virtual reality environment. To measure the 3D virtual experience, marketers also have focused on the notion of telepresence (to create an environment in which users might feel that they are transported into different places rather than the one their physical bodies are located in) to interpret how consumers perceive online retail products. This chapter is organised as follows: Section 2.2 discusses the telepresence definitions and typologies in the immersive virtual reality environments. Section 2.3 explains telepresence antecedents and consequences in the immersive virtual reality environment. Section 2.4 presents the telepresence in non-immersive virtual reality. Section 2.5 demonstrates telepresence antecedents in non-immersive virtual reality. Section 2.6 describes consumers' virtual experience on the online retailer. Section 2.7 discusses 3D telepresence and website telepresence antecedents on the online retailer. Section 2.8 explains 3D telepresence, website telepresence consequences and consumer behaviour. Section 2.9 summarises the main gaps in non-immersive virtual reality (NIVR) 3D telepresence literature and proposes a new notion to suit the online retailers and consumers when using 3D product visualisation.

2.2 TELEPRESENCE DEFINITIONS AND TYPOLOGIES IN THE IMMERSIVE VIRTUAL REALITY

VR terminologies enter the vocabulary with the emergence of immersive virtual reality (IVR) devices, such as head-mounted displays, which allow users to interact with virtual environments and to visualise different objects (Suh and Lee, 2005). As a result, the notions of telepresence or presence emerge. However, extant literature in the IVR area has provided readers with different classifications and conceptualisations of VR experiences (see Table 2.1). For example, Steuer's (1992, p.78) definition of virtual reality (VR) as "*a real or simulated environment in which a perceiver experiences telepresence*" focuses on human experience, the key to defining virtual reality and the concept of presence, not technological hardware, and differentiates between presence and telepresence virtual experiences (p.76). Whereas presence refers to "*the experience of one's physical environment; it refers not to one's surroundings as they exist in the physical world, but to the perception of those surroundings as mediated by both automatic and controlled mental processes*", telepresence is "*the experience of presence in an environment by means of a communication medium*". Steure's definitions clearly state that telepresence refers to a mediated perception of an environment, while presence refers to the natural perception. In turn, Sheridan (1992) distinguishes between virtual presence and telepresence, such that presence relates to the sense of being in a computer-mediated environment. However, telepresence indicates a sense of being in any real remote location.

Heeter (1992) argues that the subjective experience of presence, "being there" is the core of virtual world definitions. She posits that creating a sense of presence is a matter of simulating the range and intensity of the natural stimuli that human senses can detect and interpret in perceiving the natural world. According to Heeter (1992), being there consists of three different parts. First, personal presence (refers to a user's ability to feel that he or she is a part of the virtual world) depends on sensory richness, i.e., the extent to which sensory used in virtual reality creates ‘a sense of illusion’, sense of being transported into another place while the user is still in his/her place. Furthermore, high levels of sensory richness (e.g., sound, sight and touch) enhance users’ involvement, feedback, navigation and enjoyment. Second, social presence (referring to the existence of other beings in the VR world with whom users can interact, e.g., avatars) helps users to have a sense of not being alone in virtual worlds. Third, environmental presence refers to the ability of the virtual environment such as a mediate environment to acknowledge and respond to users’ orders properly.

In accordance with previous scholarly literature (e.g., Heeter, 1992; Biocca, 1997), Palmer (1995) defines virtual reality based on the interpersonal communication, which can often be achieved via social presence (immersion) and telepresence (being there). The existence of other people in a virtual reality and human ability to interact with them are considered to be the main components of a virtual reality interpersonal communication.

To that end, Biocca and Delaney (1995) argue that the definition of VR depends on technological hardware and software. The authors define VR as a perceptual immersion presence. This type of presence experience depends on sensory immersion in virtual environments. The authors posit that immersion of humans in a virtual reality requires a simulation technology which often helps users to couple their sensory organs with the output devices of the computer and aids their virtual experience. Biocca and Delaney (1995, p.64) classify the simulation technology into input and output devices which often help users to immerse in a virtual reality environment. Moreover, each device serves as a sensorimotor channel and links to the user’s body movements and response. Output devices, such as visual displays (e.g., head-mounted displays), usually provide human eyes with information. Aural displays (e.g., audio systems, headphones) often enable users to hear. Haptic (Tactile) output (e.g., vibrating pins for tactile stimulation, and Position Sensing Glove) usually enables users to create a sense of tactile illusions. Force feedback devices (such as a joystick device and a steering wheel) simulate the look and feel of things. Finally, whole body movement displays (such as motion platforms) facilitate simulating the user’s feeling of moving through a large space. On the other hand, Bioccca and Delaney (1995, p. 97) define input devices as a computer's ability to "*sense the location and actions of the user's body in space*". For example, kinematic input devices (e.g., position trackers, data gloves, data suits) often capture and digitize human movement. Moreover, the inputting smaller body movement device reads facial expressions and eyes movement. Also, voice and audio input devices often understand human voice language and respond to it accordingly.

In line with Heeter's (1992) and Biocca and Delaney's (1995) findings, Biocca (1997) differentiates between two types of presence experience. First, presence in the human-computer-interaction (HCI), also known as 'telepresence' or the illusion of being in different places far from the users' physical body. According to the author, sense of presence is highly correlated with learning, pleasure, hedonic, response, and motivation. Second, 'social presence' refers to a user feelings of the existence of another form, behaviour or presence of other intelligences (e.g., an avatar in virtual environments). Biocca (1997) describes the process of interacting with other intelligences as 'immersion' in a virtual environment. For immersion to occur, participants must embody themselves in avatars. The author classifies bodies during the progressive embodiment into three types. First, physical or self body, which reflects the real human body. Second, virtual body or self-consciousness body, which represents the users' body inside the virtual environment (i.e., the avatar). Third, schema or image body, which represents users' mental or internal body (i.e., the body that users are imagining their real body to be in the virtual environment). Moreover, Biocca (1997) argues that mind and body work together, and that the body is the communication device (i.e., through sensations) through which the mind receives and analyses stimuli. Thus, a simulation technology is an important tool that often facilitates humans' immersion in a virtual environment and allows interface between the devices (i.e., gloves, head set,) and a human body.

In turn, Slater and Wilbur (1997, p. 604) claim immersion is "*a description of a technology, and describes the extent to which the computer displays are capable of delivering an inclusive, extensive, surrounding, and vivid illusion of reality to the senses of a human participant.*" The inclusive construct refers to the extent to which physical reality is kept out. Extensive construct refers to modalities sensory accommodation range. Surrounding construct relates to a virtual reality panorama. The vivid construct relates to the resolution, and fidelity of the stimulus. The authors distinguish between immersion and presence based on subjective and objective criteria. Immersion experience is an objective description of the system's display aspects (i.e., inclusive, extensive, surrounding, and vivid). However, presence experience is a subjective phenomenon of personal evaluation of 'being there', and a function of immersion. Unlike Slater and Wilbur (1997) who focus their efforts on a technological description (i.e., a computer's display abilities) to define immersion, Witmer and Singer (1998, p. 226) focus on the level of individual differences to define immersion. Based on the concept of selective attention, *"the tendency to focus on selected information that is meaningful and of particular interest to the individual"*, Witmer and Singer (1998, p. 225) define presence as the *"subjective experience of being in one place or environment, even when one is physically situated in another"*. Moreover, the authors argue that presence is a product of both involvement and immersion experiences. While the involvement experience refers to a user's beliefs about the importance of a meaningful stimulus which often enhances the performance or usefulness of the stimulus, the immersion experience refers to the virtual environment's ability to isolate a user from his/her physical environment and to provide him/her with a sense of being part of the virtual environment (i.e., creating a psychological state that enhances the users' perception of being part of the virtual environment stimulus flow). The authors illustrate that both involvement and immersion experiences are important to produce a presence experience in virtual environments.

To extend prior literature, Lombard and Ditton (1997) identify six taxonomies of presence experience: social richness, realism, transportation, immersion, social actor within medium, and medium as social actor. First, presence as social richness, Lombard and Ditton (1997) report that scholars who followed the social richness approach used either the social presence theory or the media richness theory. Moreover, those who used the social presence theory focused on users' subjective judgment to measure their interaction with the medium and to evaluate the task they were doing. On the other hand, those who used the media richness theory focused more on objective matters (i.e., when users are less subjective in measuring a medium's immediate feedback, number of senses involved and language). Lombard and Ditton (1997, p. 4) define social richness as "*the extent to which a medium is perceived as sociable, warm, sensitive, personal or intimate when it is used to interact with other people"*. Furthermore, the authors explain that social richness depends on intimacy (a medium's ability to behave like a human from both verbal and non-verbal cues), and immediacy (a medium's ability to create psychological closeness).

Second, presence as realism. According to Lombard and Ditton (1997, p. 5) this conceptualisation of presence refers to "*the degree to which a medium can produce seemingly accurate representations of objects, events, and people-representations that look, sound, and/or feel like the real thing"*, and depends on a 'sensation of reality'. The authors differentiate between two types of realism experience: social realism and perceptual realism. Whereas social realism is related to "*the extent to which a media portrayal is plausible or true to life in that it reflects events that do or could occur in the non-mediated world"*, perceptual realism is related to the users' perception of objects and people in a virtual world (i.e., the way that objects in a virtual reality look, sound, and feeling like real people and objects).

Third, presence as transportation. This refers to transporting a user, self, or place, to another place. This taxonomy of presence has been used by previous studies (e.g., Sheridan, 1992; Steure, 1992) which used terminologies like "Being there", "You are there", "It is here" and telepresence to describe the interaction experience with a mediated-environment.

Fourth, presence as immersion. This conceptualisation of presence consists of perceptual and psychological immersion. Lombard and Ditton (1997) rely on Biocca and Delaney's (1995. p, 57) definition to describe the perceptual immersion concept "*the degree to which a virtual environment submerges the perceptual system of the user"*. However, Lombard and Ditton (1997) use Palmer's (1995) definition to describe the psychological immersion as involvement, absorption and engross states with the virtual environment.

Fifth, presence as social actor within a medium, based on Lemish (1982), Lombard and Ditton (1997, p. 9) define this type of presence as "*The degree to which users illogically overlook the mediated or artificial nature of an entity within a medium and attempt to interact with it*". Moreover, to explain this conceptualisation of presence experience, the authors indicate using avatars in the HCI field, which users can interact, speak, and deal with in real time. The authors illustrate that conceptualising presence experience in this way not only creates two-way communication, but also helps users to feel that they are communicating with an agent in real time. This psychological process often leads users to illogically ignore the mediated environment and enhance their interaction with it.

Sixth, a medium as social actor. This conceptualisation of presence experience depends on the cues provided by the medium itself rather than social responses provided by computer characteristics or people. This concept came about as the result of the computer's ability to act like a human. In other words, when users are dealing with the computer as an entity, not as a programme, they will illogically ignore the mediated nature of the computer and deal with it as a social entity rather than as a mediated-environment. The authors explain that this conceptualisation of presence experience is a function of the media's abilities (e.g., the computer) to use a natural language and to interact with the users in a real time (i.e., create real responses). As a result, users will treat the medium as a social entity.

Unlike previous researchers (e.g., Steuer, 1992; Biocca and Delaney, 1995; Biocca, 1997), who measured telepresence or presence experience via computer, Kim and Biocca (1997) measure telepresence experience by creating a virtual world in a dark room using a television set of specific size, controlling the degree of vision, and showing some demos and ads to the viewers. The authors find that 'arrival and departure' are the main dimensions of telepresence experience. Arrival describes users' experiences, in a mediated environment, of 'being there' in the virtual world. However, departure describes the absence of the mediated environment, and the sense of returning from the virtual world to the 'real' world. Kim and Biocca (1997) report that the virtual experience created by arrival and departure (i.e., sense of telepresence) enhances the sense of seeing the products and believing in the information personified in the mediated environment. Kim and Biocca (1997) find that technological levels in a TV provide users with little sensory engagement which limited their ability to enhance their sensory immersion.

To extend the extant categorisations of presence, Ijsselsteijn and Riva (2003) assert that previous research has identified two types of presence experience: physical and social presence, and has not tried to study the effect of the interception point between the two types. In other words, when it comes to chat rooms or tele-conference platforms users are indeed using both physical and social presence together. Drawing on this, the authors reclassify presence experience into social, physical, and 'co-presence'. The authors argue that co-presence is extremely important because it combines the process of being with other intelligent beings and sharing the same space. In other words, co-presence is a product of immersion in the virtual reality and the interaction with other intelligent beings (i.e., multi-user collaborative activities).

To explain the main differences between virtual experiences, Lee (2004) notes that previous scholars use different terminologies, such as mediated presence, virtual presence, and presence, to refer to the virtual experience. Lee argues that such lack of agreement on the definition of virtual experience directs scholars to illogical classifications of presence types (i.e., physical, social, and self). Lee (2004) posits that few theoretical attempts have been made to explain the difference between virtual experience and other human experiences. To address this issue, Lee (2004, p.37) defines presence experience as "*a psychological state in which virtual (para-authentic or artificial) objects are experienced as actual objects in either sensory or non-sensory ways*". Lee claims that choosing the notion of presence over other notions, such as telepresence, mediated presence and virtual presence, makes it easier for future analysis when new technologies appear. Moreover, whereas the notions of telepresence, mediated presence and virtual presence centred on technological characteristics, presence is about a psychological state of how users perceive technology-generated stimuli. In addition, using the notion of presence enables scholars to investigate real phenomena. While the notion of telepresence enables scholars to explore the feelings of being transported into a physical visualised virtual environment. Moreover, Lee argues that the process of sharply separating the mediated perception (sensation) from natural perception is futile since natural perception can be regarded as mediated. Lee explains that, even in natural physical life, people use their senses to perceive the external environment. In other words, natural perception is mediated by people's sensations. In turn, Li *et al*. (2001) claim that natural perceptions and non-mediated environment should not be included with the presence experience research because they are making the area of mediated presence too broad.

Lee (2004, p. 36) defines virtual experience as "*the experience of either para-authentic or artificial objects. That presence occurs when technology users do not notice the para-authenticity of mediated objects or the artificiality of simulated object"*. Lee (2004, p. 38) classifies three types of experience. First, virtual experience refers to the "*sensory or non-sensory experience of para-authentic or artificial objects"*. Whereas 'para-authentic objects' enables users to perceive virtual objects as real (for instance, clothes which users can find in a virtual environment, online retailer and offline retailers), 'artificial objects' refers to the technology ability to create or simulate objects that do not exist in the real world such as virtual battles. Second, real experience is *"the sensory experience of actual objects"*. Third, pure hallucination refers to the "*non-sensory experience of virtual (para-authenticity or artificial) objects"*. The author asserts that a non-sensory experience reflects presence ability to be part of mediated or non-mediated environments such as daydreams, hallucination, or reading a novel. Thus the author defines presence in a way that could be applied to different situations. Lee (2004, p. 44-46) classifies presence into three types. First, physical presence refers to a "*psychological state in which virtual (para-authentic or artificial) physical objects are experienced as actual physical objects in either sensory or nonsensory ways*". This category of presence occurs when technology users do not notice the nature of the mediated objects or environment. Second, social presence refers to a "*psychological state in which virtual (para-authentic or artificial) social actors are experienced as actual* *social actors in either sensory or non-sensory ways*". This type of presence arises when technology users do not notice the nature of the mediated human or nonhuman social actors, and often occurs whether the user is interacting with a computer or reading a novel. Third, self presence refers to a "*psychological state in which virtual (para-authentic or artificial) self/selves are experienced as actual physical self in either sensory or non-sensory ways*". This type of presence suggests itself when technology users do not notice the virtuality of the mediated environment.

2.3 TELEPRESENCE ANTECEDENTS AND CONSEQUENCES IN THE IMMERSIVE VR

Previous scholarly literature (Steuer, 1992; Sheridan, 1992; Heeter, 1992; Slater and Usoh, 1993; Biocca and Delany, 1995; Lombard and Ditton, 1997; Witmer and Singer, 1998) identifies vividness and interactivity as the main antecedents of telepresence or presence experience (see Table 2.2). For example, Steuer (1992, p. 84) defines interactivity from a device-centric perspective as "*the extent to which users can participate in modifying the form and content of a mediated environment in real time*". Moreover, Steuer (1992) identifies speed, range, and mapping as the main elements that enhance interactivity. The speed of a mediated environment often helps users to have a 'real time' response which increases users experience in a mediated environment. The range concept refers to a user's ability to modify or change the mediated environment attributes or characteristics. For instance, users' ability to change brightness of image, sounds, timbre and colour enhance their virtual experience. The mapping construct refers to the ability of technological devices (e.g., gloves, head sticking) to obey users' needs and orders. Setuer (1992) reports that the greater the ability of the users to modify the above three dimensions, the greater the interactivity of a given medium. On the other hand, Steuer (1992, p.81) defines vividness as "*the representational richness of a mediated environment as defined by its formal features; that is, the way in which an environment presents information to the senses*". The author posits that vividness is a product of two important variables: sensory breadth, and sensory depth. According to Steuer (1992, p.81), sensory breadth refers to "*the number of sensory dimensions simultaneously presented*", and it is determined by the number of senses used while interacting with a virtual environment (i.e., communication medium ability to present information across sensation perceptual channels). Virtual environments can enrich visual, auditory, haptic, and smell perception systems. However, Steuer claims that the focus of specific perceptual systems depends on the user's goal when interacting with virtual environments. For instance, if the user is interested in the visual aspects of a virtual environment then he/she would pay more attention to visual channels than anything else. On the other hand, users may pay more attention to the sound and visual perceptual channels when their goal is to play an online game.

In turn, sensory depth relates to the depth of information that a perceptual channel often provides to the users. Sensory depth is determined by the quality of the channel, according to Steuer (1992). For example, users consider a high quality visual channel (i.e., high pixels) better than visual channel with less depth (i.e., with less resolutions or pixels). The same thing is applicable to auditory representations. Steuer (1992) highlights the trade-offs between breadth and depth of perceptual system channels. For instance, a silent film provides fewer sensory channels (i.e., only visual) than a video presentation (i.e., both visual, and sound). Yet, the video presentation may be greater in breadth but not in depth. Steure (1992) explains that vividness is stimulus-driven and it depends on technological characteristics. In other words, the more vivid the information is, the less effort the surfer needs to make to understand the information. For instance, a TV provides more vividness stimuli (i.e., audio and visual) than a print advertisement or a static website. In turn, Sheridan (1992) argues that sense of virtual presence is a product of five variables: extent of sensory information, control of sensors relative to environment, ability to modify the physical environment, task difficulty, and degree of automation. In support of previous research, Biocca and Delaney (1995) report sensory vividness (media richness, operationalised as the main components of sensory vividness, number of sensory channels supported, sensory resolution within each sensory channel, the level of coordination between sensory displays and illusions, and realism), interactivity (operationalised as number and forms of input and output devices, range and responsiveness) and sociability (operationalised as the number of users a system can support) as the main criteria for evaluating an immersion in a virtual reality[1]. The authors posit that the higher the above criteria, the higher the immersion in the virtual environment. In accordance with Sheridan (1992), Lombard and Ditton (1997, p.10) identified characteristics of media form (operationalised as vividness/sensory richness such as image quality, image size, motion and colour, stereoscopic image, and aural presentation.), characteristics of media content (operationalised as objects, actors, and events represented by the medium) and characteristics of media users (operationalised as knowledge and prior experience) as the main causes of presence experience.

Witmer and Singer (1998) identify control, sensory, distraction and realism factors as the main determinants of presence experience. First, control factors which include; immediacy to control (i.e., a virtual environment's ability to respond to the user's action), anticipation of events (i.e., users' ability to predict what will happen next), mode of control (users' ability to interact easily with a virtual environment), and physical environment modifiability (i.e., a user's ability to modify a physical object in his/her virtual environment). The authors posit that the more the user controls the above factors, the more he/she experiences presence in the virtual environment. Second, sensory factors which include; sensory modality (i.e., visual information that users get from interacting with the virtual environment), environmental richness (i.e., information quantity that stimulates a sense of presence), multimodal presentation (i.e., coherent simulation of the senses), consistency of multimodal information (i.e., information received from all modality reflects the same objective world), degree of movement perception (i.e., a user's ability to observe self movement), and active search (i.e., a user's ability to modify his/her viewpoint to change what he sees or hears). The authors state that the more the technology enhances the above sensory factors, the more the presence experience in the virtual environment will be. Third, distraction factors, which include isolation (i.e., device's ability to isolate users from their actual environment), selective attention (i.e., user's ability to focus on the virtual environment and ignore other physical world), and

[1] For the purpose of this research, more focus is placed on the first three items. However, in the original article another two items are mentioned: diffusability (referring to hardware and software compatibility) and cost.

interface awareness. Fourth, realism factors which focus on pictorial and social realism of the virtual environment.

Ijsselsteijn and Riva (2003) assert that media characteristics and user characteristics are the main determinants of presence experience. Media characteristics can often be classified into media form and media content. The media form refers to sensory information (vividness), whereas media content refers to users' ability to interact, modify, and respond to social elements, such as an avatar in any virtual environment. The authors describe media characteristics as objective or external factors that help users to perceive objects and entities in their virtual environment. However, a user characteristic is related to users' perceptual, cognitive, and motor abilities. The authors describe user characteristics as subjective or internal factors that help the users to feel and respond as if there is no medium in his/her communication environment.

Table 2.1 Typologies of VR experience: telepresence/ presence definitions and dimensions

Author	Terminology	Definition	Factors/Dimensions of tele/presence
Steuer (1992, p. 76)	Telepresence	The extent to which one feels present in the mediated environment, rather than in the mediate physical environment.	• Vividness • Interactivity • Personal characteristics
Sheridan (1992, p.120)	Virtual presence Telepresence	Presence relates to the sense of being in a computer-mediated environment. Telepresence indicates a sense of being in any real remote location.	• Extent of sensory information, • Control • Modify physical environment. • Task difficulty. • Degree of automation.
Heeter (1992)	Subjective personal presence: -Personal presence -Social presence -Environmental presence	 User ability to feel that you are in virtual environment. User ability to feel and react with other intelligent beings. User ability of virtual environment to respond to user actions.	• Vividness and fidelity of sensory inputs. • Navigation.
Kim and Biocca (1997)	Presence	Being there.	Arrival and departure
Lombard and Ditton (1997, p. 10)	Presence	"The perceptual illusion of nonmediation. The term perceptual indicates that this phenomenon involves continuous (real time) responses of the human sensory, cognitive, and affective processing systems to objects and entities in a person's environment".	• Form of presenting information • Content on information • User characteristics
Slater and Usoh (1993, p. 222)	Presence	Suspension of disbelief that they [users of virtual reality systems] are in a world other than where their real bodies are located.	• Quality (resolution) • Consistency among all displays. • Interaction with

			environment • Virtual body representation. • Anticipated effect of action
Witmer and Singer (1998, p. 225)	Subjective presence	"Subjective experience of being in one place or environment, even when one is physically situated in another."	• Control • Sensory factor • Distraction factor • Realism factor
Lee (2004, p. 27)	Presence	Psychological state in which virtual objects are experienced as actual objects in either a sensory or non-sensory way.	• Vividness • Interactivity
Slater and Wilbur (1997)	Presence	The person's evaluation of their degree of "being there", the extent to which that person thinks of the virtual environment as "place like" (subject to suspension of disbelief).	Not available due to the authors focus on the notion of immersion more than the presence concept.
Biocca and Delaney (1995, p. 57)	Immersion	"The degree to which a virtual environment submerges the perceptual system of the user."	• Sensory vividness, • Interactivity, • Sociability, • Diffusability • Cost.
Ijsselsteijn and Raiva (2003)	Physical and social presence	Being there together.	• Vividness • Mapping • Content factor (interaction, modifying, and social factors) • User characteristics (perception, cognitive, and motor ability)

Source: Developed for this research (2009)

2.4 TELEPRESENCE EXPERIENCE IN NON-IMMERSIVE VIRTUAL REALITY

Previous research on IVR (e.g., Biocca, 1997; Heeter, 1992; Lombard and Ditton, 1997; Sheridan, 1992) reveals several key findings. First, researchers from different fields (e.g., communication, business, psychology, and HCI) use different terms (e.g., presence, telepresence, virtual presence, immersion, mediated presence) to describe the same concept. However, some debate remains regarding definitions of presence and telepresence. For example, whether is it a state of being mentally transported into another place, an illusion, or even an immersion state? Second, previous research uses presence and telepresence to explain VR experience. Whereas in the past researchers (e.g., Biocca, 1992; Heeter, 1992; Lombard and Ditton, 1997; Sheridan 1992; Steuer, 1992; Witmer and Singer, 1998) used display interface technologies such as goggles, head-mounted visors, data gloves, joysticks, head trackers and televisions to identify and measure telepresence or presence experiences, more recent technological developments can 'transport' users to other places, where they can see and interact with other intelligent beings (e.g., avatars in Second Life, chat rooms, online communities), without forcing them to wear technological devices. To address this issue, online retail literature introduces the non-immersive virtual reality (NIVR) environment and explains the main antecedents of telepresence experience depending either on retailers' website or 3D virtual models that can be found in retailers' websites.

2.5 TELEPRESENCE EXPERIENCE ANTECEDENTS IN NON-IMMERSIVE VIRTUAL REALITY

Previous studies in the NIVR area, particularly within the online retailers, reveal that authors either define the telepresence construct as a state of being transported into another area, or as a state of social presence (consumers can interact with a social entity in the online retailer site). To identify the telepresence experience antecedents, some authors consider interactivity and vividness the main antecedents of a web telepresence (e.g., Fortin and Dholakia, 2005) or 3D telepresence (Suh and Chang 2006; Suh and Lee, 2005), whereas others consider vividness only (e.g., Hopkins, Raymond and Mitra, 2004). Still other authors consider interactivity and vividness to be the main indicators of 3D telepresence (e.g., Kim et al., 2007; Song, Fiore and Park, 2007) but not its antecedents. The following sections explain interactivity and vividness constructs and their relationships with the web telepresence or 3D telepresence construct.

2.5.1 Interactivity

The concept of interactivity has been increasingly mentioned since the appearance of the new communication channels specifically on the World Wide Web. Interactivity is considered to be a critical concept and a primary advantage of the Internet (Morris and Ogan, 1996; Rafaeli and Sudweeks, 1997). Considerable research investigates and empirically tests the construct, but there is little agreement on the definition or operationalisation of the interactivity construct (e.g., Ariely, 2000; McMillan and Hwang, 2002; Liu and Shrum, 2002; and Klein, 2003). See Tables 2.3 and 2.4. For example, Rafaeli (1988, p.11) defines interactivity (based on a computer-mediated communication) as "*the extent to which messages in a sequence relate to each other and especially the extent to which later messages recount the relatedness of earlier message*". Rafaeli's (1988) definition of interactivity focuses on the message responsiveness and he argues that the definition of interactivity recognises three potential levels of communication. The two-way communication (refers to bilateral message flow), reactive (refers to message coherence with the previous one), and full interactivity (refers to message responsiveness). The author posits that the two-way communication and reactive communication enhance message responsiveness. However, only fully interactive communication often facilitates continuous relationships between the previous answers and previous questions. The author distinguishes between feedback and interactivity, such that feedback is a subset of interactivity. In support of Rafaeli (1988), Rafaeli and Sudweeks' (1997) empirical results find that interactivity (conceptualised as responsiveness), acted as a 'glue' that keeps online communicants together. Hoffman and Novak (1996) rely on Rafaeli's (1988) and Steuer's (1992) definitions of interactivity and identify speed and feedback as the main dimensions of (a website) interactivity. However, Wu (1999) defines perceived interactivity based on internal self-efficacy and external self-efficacy. Internal self-efficacy refers to users' ability to control their navigation (where they now and where they are going). However, external self-efficacy refers to the users' sense of responsiveness (i.e., web response to user's actions). Wu's (1999) empirical research shows that responsiveness and navigation are the main determinates of (website) interactivity.

Unlike the previous studies (e.g., Steuer, 1992; Rafaeli, 1988; Wu, 1999), Ariely (2000) defines interactivity of a website dependent on one dimension 'level of control'. Ariely (2000, p.234) focuses on the user control as the narrowest aspect of interactivity and finds that "*control over information flow had positive effects due to the changing needs for information acquisition process itself*". The author focuses on the importance of controlling the information flow, when consumers are surfing a website, to enhance consumers preferences, to improve users' memory and knowledge, and to build confidence in their judgments. Controlling the flow of information helps customers to manage (i.e., integrate and remember) and understand websites information.

In an attempt to understand interactivity dimensions, Downes and McMillan (2000) notice that the definition of interactivity is somewhat confusing. The authors carry out qualitative research in the form of in-depth interviews with expert people who worked and taught in the field of interactive communication to identify the main dimensions of interactivity. The authors identify message-based and participant-based dimensions as the main components of interactivity. Message-based dimensions include the direction of communication (a computer-mediated ability to provide participants with two-way communication), time flexibility (the ability of a computer-mediated communication environment to communicate in 'real time'), and sense of place (a medium's ability to create a virtual place in people's imagination rather than a physical presence). On the other hand, the participant-based dimensions include perceived purpose of communication (i.e., persuading or/and information), level of control (a computer-mediated environment's ability to allow a receiver to have control over the feedback loop), and responsiveness (a computer-mediated ability to respond to users' orders once they customise their message). For example, users should be able to 'drive' the search engine toward their needs and the search engine should 'respond' to a user's command properly. Unlike the previous quantitative study, McMillan (2002) identifies direction of communication (i.e., the site's ability to facilitate two-way communication) and level of receiver control over the communication process (i.e., a user's ability to change and modify the content of site components) as the main bases of interactivity in a computer-mediated cyber model. The author claims that some places in cyberspace are more interactive than others due to the existence of the above bases.

To extend previous literature in interactivity, McMillan and Hwang (2002) notice that the previous definitions of interactivity were based on one of the following explanations. First, process: scholars who used this approach focused their efforts on websites activities such as interchange and responsiveness. Second, features: scholars (e.g., Rafaeli and Sudweeks, 1997; Hoffman and Novak, 1996) who used this approach focused their efforts on either general characteristics (i.e., two-way communication and user control), or specific characteristics (i.e., chat rooms and search engines) of the website. Third: perception, scholars (e.g., Wu, 1999) who used this approach focused on users' perception or experience of websites interactivity. Fourth, combined approaches: scholars (e.g., McMillan, 2002) who used this approach centred their efforts on combining certain interactivity features (i.e., process, features and perception) to define interactivity. In turn, McMillan and Hwang (2002) posit the following factors as the most frequently appearing elements in the interactivity literature. First, direction of communication, which facilitates two-way communication, provides feedback, and interpersonal communication (e.g., Rafaeli and Sudweeks, 1997; Hoffman and Novak 1996). Second, user control refers to either human perception (i.e., interpreting computer personality and goals) or to computer design (e.g., navigation tools, interfaces and input devices). Third, time refers to the web speed, and ease of navigation.

After studying the above common dimensions of perceived interactivity (i.e., direction of communication, user control, and time), McMillan and Hwang (2002) explain that these dimensions overlap and are interrelated in much of the literature. McMillan and Hwang (2002) develop a scale to measure consumers' perception of interactivity concept. The scale includes three main constructs; two-way communication, user control and response time. The authors argue that the importance of such a scale appears significant due to the momentous role of the Internet as a tool in the new communication era. In other words, the website's ability to increase two-way communication, users' sense of control over the web content and the website's ability to respond without delay are the main elements that could enhance users' interactivity experience in the website.

Like other scholars (e.g., Downes and McMillan 2000; Downes and McMillan 2002; McMillan and Hwang 2002) Liu and Shrum (2002) explain that different definitions of interactivity can be classified according to three focuses. First, user-machine focus: according to Liu and Shrum (2002) such a focus was the heart of early definitions of interactivity. For example, Cho and Lenckenby's (1997) results define interactivity based on human-computer interaction. However, Liu and Shrum (2002) assert that explaining interactivity from this aspect only is insufficient due to the appearance of advanced technology (i.e., Internet). Second, user-user interaction: this type of interactivity is related to an interpersonal communication perspective. According to Liu and Shrum (2002) scholars who have discussed interactivity from this perspective tried to increase interactivity (by increasing communication levels in a computer-mediated environment) to make it resemble interpersonal communication. However, Liu and Shrum (2002) state that this focus of interactivity ignores the Internet's ability to create interpersonal communication. Third, user-message interaction: this aspect defines interactivity as the ability of the user to control and modify messages (e.g., Steure, 1992).

To solve the above dilemma of many definitions of interactivity from different perspectives, Liu and Shrum (2002, p. 54) propose a new definition for interactivity, based on incorporating all of the previous focuses of interactivity, "*the degree to which two or more communication parties can act on each other, on the communication medium, and on the message and the degree to which such influences are synchronised*". The authors state that the new definition of interactivity consists of three dimensions. First, active control, which refers to users' ability to customise and choose websites' contents according to their goals. In other words, when users surf the Internet they are undertaking a voluntary actions to navigate any retailer's website, for example, they can go back and forth between retailers' websites until they achieve their goals. Such actions directly influence users' controlling experiences.

Second, two-way communication. This aspect of interactivity allows users to have reciprocal communication with companies and other users. Being able to do this facilitates commercial transactions and immediate feedback. For example, online users can easily communicate with online retailers by surfing their sites, finding out more about their products' features, attributes, prices and paying directly without the need to use traditional methods. On the other hand, companies might measure users' stickiness time, track consumer behaviour online, and wait for consumers' direct feedback (i.e., sending an email, or answering an online survey about the company and its products). Scholars (e.g., Rafaile 1997; Hoffman and Novak 1996) have focused on this aspect when studying interactivity.

Third, synchronicity (speed and responses). Liu and Shrum (2002, p. 55) define synchronicity as "*the degree to which users' input into a communication and the response they receive from the communication are simultaneous*". The authors explain that the higher the system's responsiveness (i.e., the system responds to consumer's orders), the higher the interactivity. For example, search engine interactivity could be considered as high if a customer finds what he/she seeks quickly. Scholars (e.g., Steuer, 1992; Wu, 1999; McMillan and Hwang, 2002) have focused on this aspect of interactivity. In support of previous research (e.g., Ariely, 2000; Coyle and Thorson, 2001), Liu and Shrum (2002) find that the active control element has received the most attention among the three dimensions (i.e., active control, two way communication and synchronicity).

To extend the previous literature, Kiousis (2002) notices that interactivity as a concept has been defined in different ways and has no specific operational definitions. For example, previous scholars have opertionalised interactivity from three different disciplines. First, the structure of technology focuses on technological aspects such as speed, range, and mapping (e.g., Steuer, 1992).

Second, the communication context centres its effort on investigating the effects of direct communication and social presence on interactivity concept (Rafaile 1997; Hoffman and Novak 1996). Third, user perception stresses the importance of real-time, sensory activation (i.e., telepresence) and perceived speed (e.g., Steuer, 1992). Kiousis (2002) argues that the above perspectives are efficient in identifying interactivity but they do not work separately. Previous studies tended to use one of the above three perspectives when defining interactivity. For example, at one extreme, Steuer (1992) defined interactivity from a technological perspective (i.e., speed, range, and mapping) but the mapping elements are more related to the computer software. Speed is something relative, thus what is considered to be a fast speed for a computer now may be considered to be a very slow speed in the future. At the other end of the spectrum, Rafaeli (1988) defined interactivity based on direction of communications without giving any attention to technological perspectives. However, Kiousis (2002) reports that using responsiveness only to measure interactivity (i.e., Rafaeli's definition) may not allow users to modify or change the mediated environment. Based on the above, Kiousis (2002, p.372) suggests a new hybrid definition for interactivity: "*The degree to which a communication technology can create a medium environment in which participants can communicate (one-to–one, one-to-many, and many-to-many), both synchronously and asynchronously, and participate in reciprocal message exchange (third-order dependency). With regard to human users, it additionally refers to their ability to perceive the experience as a simulation of interpersonal communication and increase their awareness of telepresence*."

Yadav and Varadarajan (2005) classify previous work on interactivity (especially for the computer-mediated communication) into three categories. First, device-centric perspective refers to the abilities of technological devices (i.e., computers and computer based technology) to facilitate or hinder communication between individuals. Scholars (e.g., Steuer's, 1992; Lombard and Ditton, 1997; Downes and McMillan, 2000) who followed this perspective have focused on the importance of control when defining interactivity. Yadav and Varadarajan (2005) note that the main goal of previous scholars (e.g., Steuer, 1992; Biocca, 1997; Lombard and Ditton, 1997), who concentrated their efforts on the device-centric perspective, was to create a sense of presence (i.e., a feeling of being transported to other places) and it was a means to an end. Second, a message-centric perspective refers to the relationships between a set of messages when exchanged. This type of relationships can be best described as the ‘feedback’ or the ‘responsiveness’ between a set of messages. Scholars (e.g., Rafaeli, 1988; Rafaeli and Sudweeks, 1997; Wu, 1999; Downes and McMillan, 2000) who focused on this perspective have concentrated on the importance of responsiveness in a computer-mediated communication. Third, complementary nature of device- and message-centric perspectives, refers to the use of both perspectives (i.e., device and message-centric). This perspective was found to be effective when previous scholars used it (e.g., Kiousis, 2002; McMillan and Hwang, 2002).

Based on these perspectives, Yadav and Varadarajan (2005, p. 593) define interactivity construct in the electronic marketplace as “*the degree to which computer-mediated communication is perceived by each of the communicating entities to be (a) bidirectional, (b) timely, (c) mutually controllable, and (d) responsive”*.

Unlike the previous scholars (e.g., Downes and McMillan, 2000; Downes and McMillan, 2002; McMillan and Hwang, 2002; Liu and Shrum, 2002; Kiousis, 2002; Yadav and Varadarajan, 2005), who defined and measured interactivity in a computer-mediated environment, Johnson, Bruner and Kumar (2006) attempt to find a comprehensive conceptualisation for interactivity which can be applied and generalised to all fields (i.e., mediated and non-mediated).

Johnson *et al*. (2006) review all interactivity definitions and find that previous definitions of interactivity lack comparability and generalisability due to the following drawbacks. First, previous research (e.g., McMillan and Hwang, 2002; Liu and Shrum, 2002) has highlighted specific technologies (i.e., WWW, Voice over Internet Protocol (VoIP) and online gaming) or technology features (i.e., hypertext, multimedia) rather than the concept of interactivity itself to measure interactivity construct. Second, interactivity dimensions have been studied in different ways but no study has identified the antecedents of interactivity. For example, Liu and Shrum (2002) reported two-way communication and synchronicity as the main dimensions of interactivity. Ariely (2000) and Liu and Shrum (2002) studied control over the flow of information as the main dimension of interactivity. Yet, none of the above studies has identified interactivity antecedents or investigated the effect of non-verbal aspects of communication on interactivity. Based on the above drawbacks Johnson *et al*. (2006, p.41) introduce their new definition of interactivity which helps explain any mediated (technology-based interactivity) and non-mediated (face to face) interactivity as *"the extent to which an actor involved in a communication episode perceives the communication to be reciprocal, responsive, speedy, and characterized by the use of non-verbal information"*. Johnson *et al*.'s (2006) contribution arises from the addition of a new antecedent to the interactivity concept (i.e., non-verbal information). After reviewing the previous work on interactivity field, Johnson *et al*. (2006) report that the three main facets of interactivity that can be found in the previous work (e.g., Steure, 1992; Wu, 1999; Rafaeli, 1988; Rafaeli and Swdweeks, 1997) about interactivity are; reciprocity (perception of a communication such as number of clicks to access the needed information, navigation and number of times a communication medium responds to users' commands), responsiveness (the responses in a communication medium are perceived as appropriate and relevant), and speed (immediate response of a communication event). Johnson *et al*. (2006) add a fourth facet to the previous facets, namely, non-verbal information, which refers to a communication medium ability to facilitate non-verbal information such as animation, video, pictures, graphics, music, and sound.

Johnson *et al*. (2006) empirically test the effects of the above facets on perceived communication interactivity. The authors find that responsiveness, the speed of response, non-verbal information, and reciprocity are antecedents to perceived interactivity (second-order formative construct). User's perception of communication interactivity is strongly influenced by the extent of non-verbal information, responsiveness, and response speed. In addition, the authors find that non-verbal information has the strongest effect on perceived interactivity. However, the reciprocity effect on perceived interactivity was not supported. Finally, the authors find a positive relationship between attitude toward the website, user involvement and perceived interactivity.

Table 2.2 Interactivity Dimensions.

Dimension	Items	Author/s
Structure of technology	Speed Range Timing flexibility Sensory complexity Control Response time	Steuer (1992); Kiousis (2002) Steuer (1992) ; Kiousis (2002) Downes and McMillan (2000) ; Kiousis (2002) Steuer (1992); Kiousis (2002) Ariely (2000); Downes and McMillan (2000); McMillan (2002); McMillan and Hwang (2002); Liu and Shrum (2002) ; Kiousis (2002) McMillan and Hwang (2002); Liu and Shrum (2002); Kiousis (2002)
Communication (message) context	Third-order dependency Social presence Two-way communication Responsiveness	Rafaeli, (1988); Rafaeli and Sudweeks (1997) ; Kiousis (2002) Steuer (1992) ; Kiousis (2002) Rafaeli, (1988); Rafaeli and Sudweeks (1997); Downes and McMillan (2000); McMillan (2002); McMillan and Hwang (2002); Liu and Shrum (2002) ; Kiousis (2002) Rafaeli, (1988), Downes and McMillan (2000) ; Kiousis (2002)
User perception	Proximity Sensory activation Perceived speed Telepresence	Steuer (1992) ; Kiousis (2002) Steuer (1992) ; Kiousis (2002) Wu (1999) and Newhagen (1995) ; Kiousis (2002) Steuer (1992) ; Kiousis (2002)
Mediated and non-mediated environment	Reciprocity Responsiveness Speed and non-verbal information	Johnson et al. (2006); Yadav and Varadarajan (2005) Johnson et al. (2006); Yadav and Varadarajan (2005) Johnson et al. (2006)

Source: Developed for this research (2009)

Table 2.3 The main characteristics of perceived interactivity based on previous research

Study author/s	Perceived interactivity factors
Newhagen et al. (1995, p.165)	The definition based on efficacy: viewers' psychological sense of efficacy and viewers' sense of the media system.
Steure (1992)	- Speed, range and mapping
Rafaeli and Sudweeks (1997)	Responsiveness
Hoffman and Novak (1996).	- Person-interactivity: (Ability to communicate with other people) - Machine-interactivity: (Ability to access hypermedia)
Wu (1999)	Responsiveness and navigation
Ariely (2000)	Control
Downes and McMillan (2000)	Message-based dimensions: - Direction of communication - Time flexibility - Sense of place Participant- based dimensions: - Level of control - Responsiveness - Purpose of control
McMillan and Hwang (2002)	- Direction of communication - User control - Time
McMillan (2002)	Perception-based: - Direction of communication - Control level Feature-based: - Features that facilitate two way communication - Features that facilitate receiver control of communication
Kiousis (2002)	Structure of technology: - Speed - Range - Timing flexibility - Sensory complexity Communication context: - Third-order dependency - Social presence User perception: - Proximity - Sensory activation - Perceived speed - Telepresence
Liu and Shrum (2002)	- Active control - Two way communication - Synchronicity
Yadva and Varadarajan (2005)	- Bidirectional – Timely - Mutually controllable - Responsiveness
Johnson et al. (2006)	- Responsiveness - Reciprocity - Non-verbal information - The speed of response
Song and Zinkhan (2008)	Perceived communication (message type: personalised) - Perceived control. (number of clicks) Perceived responsiveness (time)

Source: Developed for this research (2009)

2.5.2 Vividness

The concept of vividness (also known as media richness) has been established in the immersive virtual reality environment and it has been used in the non-immersive virtual reality environments. Online retail literature has defined and operationlised vividness (to conceptualise telepresence experience) in different ways to suit the context of the studies. For example, Shih (1998) operationalises vividness based on the multi-sensory information, and identifies two major aspects; breadth (number of sensory) and depth (resolution). Furthermore, Coyle and Thorson (2001) operationalise vividness based on audio and animation. Klein (2003) holds media depth (resolution) constant and uses media breadth elements such as full motion, video and audio. Fortin and Dholakia (2005) operationalise media richness based on breadth (colours, graphics) and depth (quality and resolution). In turn, Hopkins *et al.* (2005) operationalise vividness based only on media breadth (motion, animation and music). To operationalise vividness, Keng and Lin (2006) use media depth (orienting, visual, auditory, touch and test systems), but not media breadth. Also Suh and Lee (2005) define vividness base on vision and hearing. Finally, Song *et al.* (2007) define vividness base on visual aspects.

2.6 CONSUMERS' VIRTUAL EXPERIENCE IN THE ONLINE RETAILER

When consumers are shopping, they buy benefits or experiences rather than physical products (Pine and Gilmore, 1998). To assess the experience that a specific product provides, consumers seek more learning or information about the product and about how buying it will enhance their expectations of the experience (Hoch and Deighton, 1998). Most of the scholars (e.g Li *et al.*, 2001, 2002, 2003) who have researched 3D product visualisation forms and their effects on consumer behaviour, in the online shopping context, have focused on 3D's ability to enhance the virtual experience as a new kind for consumers' experience. This section explains the main studies that consider the importance of using product visualisation forms for online retailers and the impact of 3D product visualisation on consumer behaviour.

2.6.1 Virtual Experience (3D Product Visualisation) and Indirect Experience (2D Static Product Visualisation)

Scholars (e.g., Li *et al.*, 2001, 2002, 2003) classify experiences, based on the interaction between a product or an environment and an individual, into three types. First, direct experience permits consumers to interact (e.g., physically) directly with a product. For example, when users are planning to buy a product from a high street retailer, they can directly interact with the product (i.e., roll the product, move it, and see the different colours) by using almost all of their senses. Second, indirect experience often allows consumers to interact with second-hand sources, such as static visual pictures or two dimensional (2D) products. For example, all the print adverts can be classified as indirect experience since users cannot change the content of the ad and cannot use all of their senses when interacting with the product. Third, virtual experience allows consumers to interact with three dimensional (3D) virtual models.

Even though 3D and 2D product visualisation forms require a medium to occur, the main difference between an indirect experience and a virtual experience is that the latter enhances and enriches users' experience since the user can use almost all of his/her senses when interacting with a 3D product visualisation. For instance, when users navigate a 3D product visualisation they can use their sight, hear voices, use the mouse to zoom in or out on the product, roll it, move it, rotate it, and change the colours of the product. These actions often enrich users' virtual experience, enhance their understanding and enable them to feel the product animation with its depth and breadth (i.e., vividness) (Li *et al.*, 2001, 2002). Understanding online consumers' experience lies at the heart of the virtual experience. Li *et al.* (2001. p. 14) define virtual experience as "*psychological and emotional states that consumers undergo while interacting with 3D environment*". 3D provides consumers with the ability to interact with the product, enriches consumers' learning processes, and creates a sense of being in a simulated real world (Klein, 2003; Li *et al.*, 2001, 2002, 2003). Li *et al.* (2001, p. 27) carry out a protocol analysis to examine the content of virtual experience in e-commerce. The authors posit that "*virtual experience consists of vivid, involving, active, and effective psychological states occurring in an individual interacting with three-dimensional computer simulations*". The authors assert that using 3D in the online retailer enhances consumers' ability to interact vividly with the virtual products, it increases their abilities to inspect virtual products and it provides them with more information about the products. Li *et al*. (2001) explain five characteristics of 3D product simulations that facilitate and enhance users' understanding of the virtual experience.

First, 3D enhances virtual affordance: this feature refers to a 3D ability to facilitate consumers' learning processes as a result of their ability to zoom in or out of a product and to inspect it from different angles. The authors describe this feature as 'virtual affordance' to differentiate it from the physical affordance which happens in real high street stores where consumers can touch, see, feel, and smell the products when interacting with them. Second, 3D enhances product presence: this feature refers to the ability of the 3D product visualisation to create a sense of being transported into a real physical place. In other words, users' ability, for example to zoom in or out a 3D ring, change the ring's colours, and the ability to write his/her name inside the ring, creates a psychological sense of being transported into an offline retailer. The authors' findings indicate that when participants deal with high levels of presence, i.e., products simulated in 3D, they treat the virtual products in a similar way as if they were in a physical location. Third, 3D enhances involvement: this characteristic refers to the ability of 3D virtual experience to simulate products and to provide users with more information. Fourth, 3D enhances enjoyment: this feature refers to the ability of 3D virtual experience to create fun, entertainment and a pleasurable atmosphere. Li *et al*. (2001) suggest that enjoyment is mainly related to either the innovative nature of a 3D simulation or to the virtual affordance which participants experienced. Fifth, 3D enhances active process (knowledge): this characteristic refers to the ability of 3D to attract users' attentions towards products' attributes, to provide users with beneficial information about the product features (i.e., provide users with a wide breadth of information), and to enhance users' ability to evaluate such information. For example, if participants show a high interest in the way 3D simulates a leather band, they often start seeking more information about it by surfing the retailer site.

2.6.2 3D and 2D Product Visualisation Forms and the Virtual Experience

Previous research on the 3D virtual models and 2D static pictures (Kim and Forsythe, 2007, 2008; Kim and Biocca; 1997; Li *et al*., 2003; and Suh and Lee, 2005) report the importance of 3D product visualisations in enhancing consumer learning in the online retailer. For example, Kim and Forsythe's (2007) study finds 3D product visualisation as a richer source of entertainment and fun in comparison to 2D static pictures. Fiore *et al*. (2005a) emphasise the importance of a high level of 3D product visualisation as a rich source for the experiential value. Fiore *et al*. (2005b) find that a high level of 3D product visualisation is a prosperous source of pleasure. In addition, Kim *et al*. (2007) posit that a high level of 3D product visualisation enhances consumers' enjoyment more than a 2D static pictures. Kim and Forsythe's (2008) empirical result reveals that 3D virtual models and 2D static pictures produce functional roles. A 3D rotation view has two roles; functional and hedonic with slightly higher functional role. The authors state that, as with 3D, 2D has a more functional role than hedonic role. In turn, Suh and Lee (2005) report the ability of 3D products to enhance consumers' knowledge more than 2D products. Fasolo *et al*.'s (2006) empirical results reveal that consumers' attention is accentuated towards the online retailer which has 3D animation products instead of 2D static pictures. To that end, Jiang and Benbasat (2007. p, 478) delineate that the 2D static picture and 3D product visualisation presentation forms equally provide the same knowledge (i.e., the extent to which consumers actually understand product information) when a consumer is seeking the utilitarian information about a high task complexity product (such as a laptop).

2.7 3D TELEPRESENCE AND WEBSITE TELEPRESENCE ANTECEDENTS IN THE ONLINE RETAILER

In conceptualising consumer experiences in cyberspace, Shih (1998) posits that the vividness of the information (operationalised as multi-sensory information, i.e. breadth and depth) that a consumer receives in cyberspace and the interactivity of the cyberspace technology (operationalised as control, speed and feedback) provide the main antecedents of a website telepresence experience. In turn, Coyle and Thorson

(2001) investigate the effects of progressive levels of interactivity and vividness on web marketing sites by manipulating levels of interactivity (number of choices and presence of a clickable image) and vividness (audio and animation). The authors find that high levels of interactivity and vividness increase participants' feelings of "being there" (i.e., telepresence experience). Fortin and Dholakia's (2005) empirical research reveals the direct and indirect impacts of interactivity (degree of control and response time) and vividness (breadth and depth of the message; colours, graphics, quality and resolution) on social presence experience (i.e., telepresence). High levels of interactivity and vividness have significant impact on perceived social presence experience. Interactivity has a direct significant impact on social presence. According to Klein (2003), Macromedia's Authorware© 3.0 and 4.0 represent simple technology and thus provide another means to examine the effects of telepresence experience (being transported into another area) on consumer responses. Moreover, Klein (2003) finds that interactivity (user control) and media richness (breadth of sense channels) emerge as the main antecedents of telepresence, with significant positive influences on its creation. Yang and Wu (2009) posit that interactivity and vividness are the main antecedents of 3D telepresence. Li et al.'s (2002) empirical research reveals that vividness and interactivity have significant positive influence on 3D telepresence creation. Table 2.4 summarises previous studies of retailers' website telepresence and 3D product visualisation telepresence, the sample, main stimuli used, methodological designs and 3D telepresence antecedents in the online retailer.

Schlosser (2003, p. 184) focuses on two main functions of object interactivity, "*which allows the user to directly manipulate objects in a virtual world*". Vividness of mental imagery (helps users to simulate products) and cognitive elaboration (helps users to collect and process information from the object interactivity).

Fiore and Jin (2003) examine the effect of one aspect of interactivity, namely 'image interactivity' of apparel websites on consumer responses. Fiore and Jin (2003, p. 38) define image interactivity as "*the ability to create and manipulate images of a product or environment on a website*". The authors posit two antecedents of the image interactivity technology (IIT). First, active process (control), which refers to the ability of image interactivity to enhance consumer's ability to select the products, develop the simulated body (i.e., 3D virtual model) to match the users' sizes, change the colour of the selected products and view the product from different angles. Second, presence (vividness), which refers to the ability of image interactivity to enhance visual stimuli.

Based on Fiore and Jin's (2003) study, Fiore *et al*. (2005a, p. 39) define image interactivity technology (IIT) as "*Website features that enable creation and manipulation of product environment images to simulate or (surpass) actual experience with the environment"*. Fiore *at el*. (2005a) identify two levels of image interactivity technology in apparel sites. First, a low level of image interactivity technology, which allows users to enlarge the front views of the products. This type of IIT has few interactivity options. Second, a high level of image interactivity technology, which allows users to zoom in or out, rotate and move the 3D products. This type of IIT has more interactivity options in comparison to the low level of IIT. Moreover, the authors distinguish between two kinds of high image interactivity technology: (i) mix-and-match technology that enables users to mix-and-match clothes and simulates how clothes look together, and (ii) 3D virtual model technology which can simulate the appearance of apparel products on a body form that users can zoom in or out, rotate and change the colours of the garments. Based on Klein's (2003) study (which investigates the effects of simple levels of technology on consumer behaviour), and on Sheridan's (1992) definition of telepresence experience (which includes three determinants: the ability to control stimulus, the ability of online sensation information to approximate the real world, and the ability to modify the stimulus), Fiore *et al*.'s (2005a) empirical research reveals interactivity and vividness are the main indicators of 3D telepresence experience (ability of IIT to create a sense of being transported to another place). It asserts that virtual models often boost telepresence experience concept by providing more interactivity options and enhancing sensation levels.

Keng and Lin (2006) investigate the impact of different telepresence levels on participants' ability to recall and recognise Internet advertisements. The authors classify telepresence into three levels (content presence, social presence and personal presence) and investigate their impact on Internet advertisements. Keng and Lin's (2006) study investigates the influence of visual imagery (i.e., vividness depth) while holding vividness breadth constant on telepresence. The authors find positive relationships between high levels of visual imagery and different levels of telepresence. High levels of telepresence, of an Internet advertisement, enhance participants recall and recognition. In accordance with Novak, Hoffman and Yung (2000), Huang (2003) posits the importance of flow experience (operationalised as control, attention, curiosity and interest) in designing website attributes. The author identifies interactivity (active, responsiveness, synchronicity, and reciprocity), complexity (the amount of information), and novelty (the experience or information) as the main antecedents of flow experience (telepresence).

2.8 3D TELEPRESENCE AND WEBSITE TELEPRESENCE CONSEQUENCES IN THE ONLINE RETAILER

Shih (1998) posits that enjoyment, play and fun (i.e., experiential consumption aspects) are the main consequences of the telepresence experience construct. Li *et al.* (2003) investigate the influence of 3D product visualisation characteristics (virtual affordance and media richness) on brand attitudes and purchase intention. The authors' results reveal that virtual affordance (i.e., users' ability to interact with 3D through rotating, customising and zooming in or out the product) has a positive influence on brand attitudes and purchase intention. The authors argue that in material products (e.g., bedding) participants inability to touch the bedding materials did not influence their attitudes or purchasing intentions due to participants feeling of the virtual affordance that a 3D product visualisation often enhances. In addition, the authors posit that 3D product visualisations can strongly impact users' cognitive and affective evaluations. Affective evaluation refers to users' feelings of pleasure and fun, whereas cognitive evaluation refers to the 3D product visualisation's ability to attract users' attention, enhance their product knowledge, encourage them to get more information and have a better comprehension of the brand name and products attributes.

Coyle and Thorson (2001) posit that high levels of vividness have a stronger effect on attitudes than do high levels of interactivity. Furthermore, high levels of vividness help users to create more enduring attitudes with no effects of interactivity on attitudes. Li *et al.*'s (2002) empirical research reveals 3D telepresence is mediating the relationships between 3D product visualisation and product knowledge, brand attitudes and purchasing intention. Klein (2003) asserts that a website telepresence had a significant and positive impact on persuasion levels (i.e., attribute and product) and cognitive responses. Klein (2003) finds telepresence mediating the relationship between user control, media richness and persuasion. Kim and Forsythe (2007) investigate the effects of adopting product virtualisation technologies (e.g., Virtual Try-on models and 3D virtual product demonstrations) for online apparel retailers. The empirical results show that perceived entertainment (measured by hedonic motivations) is stronger in predicting attitudes than perceived usefulness (measured by the utilitarian motivations). Moreover, the authors find that 3D product virtualisation provides participants with greater hedonic benefits than functional benefits. In turn, Kim and Forsythe's (2008) empirical result reveals that a 3D rotation view provides users with functional and hedonic values with slightly higher functional role. In the same context, Lee *et al.* (2006) investigate the role of a Technology Acceptance Model (TAM) in explaining the effects of 3D image interactivity technology on consumer responses. The authors find significant indirect effects of the 3D virtual models on attitude and behavioural intention toward online retailers mediated by the direct effects of the TAM's perceived usefulness, perceived ease of use and perceived enjoyment. In other words, the findings indicate that consumers' perceptions toward high levels of image interactivity technology (i.e., in the case of using 3D virtual models) enhanced perceived usefulness, perceived ease of use and enjoyment. The 3D perceived usefulness has a stronger effect on attitude and behavioural intention toward the online retailer than the 3D perceived ease of use has. Furthermore, the 3D perceived enjoyment has the strongest effect on attitude toward online retailers in comparison to 3D perceived usefulness and perceived ease of use. Perceived enjoyment has a significant indirect effect on behavioural intention mediated by attitude toward the online retailer. Utilitarian shopping orientation had a significant effect on perceived usefulness and perceived ease of use. Hedonic shopping orientation had a significant effect on perceived enjoyment of the image interactivity technology.

Suh and Lee (2005) report that a 3D virtual reality interface produces high levels of interactivity, vividness and telepresence. Furthermore, telepresence has strong relationships with product knowledge, product attitude and purchase intentions. Suh and Chang's (2006) research reveals a positive relationship between 3D product visualisation and telepresence. A 3D telepresence has significant positive impacts on product knowledge. Furthermore, a 3D telepresence helps consumers to collect more information about the products' characteristics and features, and enhances consumers' purchase intention.

Fiore and Jin (2003) assert that IIT has two main consequences. Entertainment (enjoyment) and involvement (perceived relevance). Involvement often enhances consumers' evaluation of a product, either because they own it or they have seen it on a body (i.e., a 3D virtual model) that is similar to theirs. Fiore and Jin's (2003) empirical research reveals that using image interactivity (mix-and-match) has a positive influence on approach responses (global attitude, willingness to purchase, willingness to return to the online store, likelihood of spending more time than planned shopping online, and likelihood of patronizing the online retailer's bricks-and-mortar store). The authors highlight the importance of the latter especially in the case of clothes where some textural information is still important to consumers.
Fiore *et al*.'s (2005a) study, regarding the 3D virtual model in the Lands' End apparel site, reveal that a high level of IIT does not have a direct effect on consumer responses (i.e., attitude toward the online retailer, willingness to purchase from the online retailer and willingness to patronize the online retailer). Rather it has an indirect effect on consumer responses mediated by the sense of telepresence that the technology creates. A high level of IIT increases telepresence, which has a significant direct effect on instrumental value, experiential value and consumer responses. Furthermore, telepresence, instrumental value and experiential value mediate the relationships between the high level of IIT and consumer response variables. In turn, Fiore *et al*. (2005b) empirically test the impact of mix-and-match models on users' pleasure and arousal. The authors find that using mix-and-match models increases users' pleasure and arousal.

Fortin and Dholakia (2005) find that involvement and arousal are the main consequences of social presence. In the same context, Hassanein and Head (2007) report positive significant effects of perceived social presence level of a commercial website on perceived usefulness and enjoyment. The authors assert that the higher the social presence (a sense of human contact, sociability and human warmth) in a website the greater the consumers perceived usefulness (i.e., being able to give more information about apparel products) and perceived enjoyment.

Hopkins *et al*. (2004) posit the importance of perceived telepresence (measured by media richness but not interactivity) in influencing attitude toward the advert, the brand and, thus, purchase intention. Moreover, the authors report an indirect impact of perceived telepresence on attitudes and purchase intention moderated by involvement. Song *et al*. (2007) investigate the impact of using a 3D virtual model, in the online apparel site, on consumers' responses. The empirical results show that 3D telepresence affects fantasy and shopping enjoyment. Moreover, the authors find that 3D telepresence, fantasy and shopping enjoyment positively affect consumers' willingness to purchase. To measure the 3D telepresence construct, Song *et al*. (2007) used Fiore *et al*.'s (2005a) scale, which did not consider any antecedents for the 3D telepresence construct. Instead, it considers interactivity and vividness as the main indicators of 3D telepresence. Yang and Wu (2009) posit that hedonic and utilitarian values are the main consequences of 3D telepresence. Moreover, the authors find that telepresence and its consequences have indirect effects on behavioural intention mediated by satisfaction. Hoffman and Novak (1996) and Novak *et al*. (2000) investigate the importance of the flow concept in understanding online consumer behaviour and online shopping experience. Novak *et al*. (2000, p. 22) define flow on the web as *"a cognitive state experienced during navigation that is determined by (1) high level of skills and control; (2) high levels of challenge and arousal; (3) focused attention; and (4) is enhanced by interactivity and telepresence"*. Novak *et al*. (2000) find that skills, challenge and telepresence have a positive and significant impact on flow experience and exploratory behaviour. The authors find a positive relationship between flow and exploratory behaviour if the exploratory behaviour is modelled as an outcome of flow. However, if exploratory behaviour is modelled as a parallel and independent outcome of telepresence then the above relation is rejected. The authors stated that flow is enhanced by telepresence. Huang (2003) posits that utilitarian and hedonic performances are the main consequences of 3D telepresence shopping experience. Kim *et al*. (2007) investigate the effects of different levels of IIT on consumers' approach responses following the Stimulus-Organism-Response (S-O-R) framework. The authors find that a high level of IIT (3D virtual model) enhances users' responses towards the online retailer (i.e., desire to stay and patronage intention to the online retailer). A 3D virtual model provides participants with high levels of enjoyment, involvement and online store perceptions in comparison to enlarge images technology (a low level of IIT). Also, the authors find that shopping involvement and online store perception positively influence users' responses towards online retailers.

It could be noticed that previous scholars (e.g., Coyle and Thorson 2001; Fiore *et al*., 2005a; Kim *et al*., 2006; Li *et al*., 2001, 2002, 2003; Yang and Wu, 2009) have reported the importance of 3D telepresence consequences as tools that enhance consumption experience aspects (i.e., instrumental and experiential values). However, many of the previous scales that have been used to measure online shopping values were originally established to measure offline shopping experiences. Recently, virtual experience in cyberspace has attracted the attentions of many online scholars who have investigated the main values that 3D product virtualisation technology may offer to consumers (e.g., Coyle and Thorson 2001; Li *et al*., 2001, 2002, 2003). Online studies have focused on the main values that consumers are seeking when they are shopping online. On the one hand, there are some similarities between online and offline values such as seeking information, enjoyment, fun and escapism, whilst on the other hand, the main differences between offline and online shopping environments are centred in the heart of technological aspects, such that the nature of the former is real whereas the nature of the later is virtual. Also, whereas in an offline shopping environment users can see the normal size of the product while in an online shopping environment the size of the product is either small or flat (Demangeot and Broderick, 2007). The following sections explain the key articles that have discussed the main offline and online shopping values.

2.8.1 Offline Consumers' Shopping Values

Previous offline literature (e.g., Babin, Darden and Griffin, 1994; Batra and Ahtola, 1991; Bettman, 1979; Holbrook, 1986; Holbrook and Hirschman, 1982) empirically test the main motivations and values that customers can get from direct consumption experiences. For example, Bettman (1979) focuses on the rational aspects of consumers' consumption experiences (information processing model), which consists of the Cognitive-Emotion-Behaviour (C-E-B) model. However, Holbrook and

Hirschman (1982) argue that the emotional part of the C-E-B model is related only to specific items (e.g., like and dislike) and does not reflect the full range of consumers consumption experiences and their state of emotions. To solve this dilemma, Holbrook and Hirschman (1982) focus on the importance of fun, fantasy, enjoyment, and entertainment within a shopping experience. The authors describe these (i.e., fun, fantasy, enjoyment, and entertainment) as experiential aspects (non-verbal cues) of the consumption experience. To that end, Holbrook (1986) proposes the Consciousness-Emotion-Value (C-E-V) model to identify the main aspects of the consumption experience. Holbrook (1986) posits that the consciousness part (C) includes cognition (beliefs) about the products or the environments, and mental playfulness. The emotion part (E) includes subjective feelings (i.e., joy, excitement). The value part (V) explains consumers' gain from the consumption process (i.e., a hedonic value like pleasure that comes from sensory elements).

Batra and Ahtola (1990) posit that attitude towards brands and behaviours consists of two major components; hedonic and utilitarian values. The authors (p. 168) assert that the "*hedonic component is associated with sensory, experiential product attributes, while utilitarian is associated with more instrumental, functional attributes",* and identify a scale for measuring hedonic and utilitarian aspects of attitude. The utilitarian part of the attitude refers to data collecting, analysing, and interpreting (i.e., instrumental aspects). However, the hedonic part of the attitude refers to the senses' ability to create fun, excitement, and playfulness (i.e., experiential aspects).

Based on the consumption (experiential and instrumental) outcomes, Babin *et al.* (1994) develop a scale for measuring consumers' shopping values. The authors introduce their scale based on hedonic and utilitarian values that most people are seeking when being involved in a shopping experience. Babin *et al.*'s (1994) research reveals that hedonic values are related to fun, enjoyment, and escapism. However, utilitarian values are related to cognitive assessment of the shopping experience. Furthermore, the authors' scale reflects consumers' perception of emotional and cognitive aspects of the shopping experience. According to Babin *et al.* (1994), consumers can use this scale not only to assess shopping experience values but also to assess product characteristics (i.e., price and quality).

2.8.2 Online Consumers' Shopping Values

Demangeot and Broderick's (2006, p.327) qualitative research on the experiential intensity of the online shopping environment, reveals that experiential intensity ("*the degree to which a website is perceived as a rich mediated space, conductive to consumer's participation in a stimulating and memorable shopping visit")* is a key element in enhancing the online shopping experience. In order to measure the experiential intensity, the authors focus on four key concepts of the website: experience, vividness, interactivity, and aesthetics. Demangeot and Broderick (2006) report four dimensions of the experiential intensity construct. First, context familiarity refers to facilitating hedonic and utilitarian benefits to consumers when they experience virtual shopping environments. Second, product presence refers to the creation of the telepresence state (with its two dimensions: vividness and interactivity) which often helps consumers to evaluate products, experience products and facilitate approach behaviour in an online shopping environment. Third, visual impact refers to aesthetics elements which usually enhance online environment atmospheric qualities. Fourth, site-user understanding refers to consumers' perception of the site's ability to enhance two-way relationship. In turn, Demangeot and Broderick (2007, p. 881) find the impact of sense-making potential ("*the perceived ability of a retail website to facilitate the consumer's orientation, navigation and task accomplishment")* on involvement is mediated by exploratory potential ("*the perceived ability of the site to provide scope for further exploration over and beyond what is visible to consumers on the page they are viewing"*). Involvement produces both hedonic and utilitarian values and both values increase the intention to revisit the site.

Based on the Theory of Reasoned Action (TRA), Davis, Bagozzi and Warshaw (1989) developed a technology acceptance model (TAM), which assumes that beliefs about usefulness and ease of use are the key determinants of information technology (IT) adoption. Moreover, according to Davis *et al.* (1989, p.320), perceived usefulness in TAM is "*the degree to which a person believes that using a particular system would enhance his job performance*". However, perceived ease of use in TAM is defined as *"the degree to which a person believes that using a particular system would be free of effort"*. TAM is valid in predicting an individual's acceptance of various corporate information technologies. Factors contributing to the acceptance of new IT are likely to vary with the technology, target users, and context. Since the appearance of TAM, many studies have tried to extend the model. For example, Venkatesh and Davis (2000) extend TAM by identifying subjective norms, image, job relevance, output quality, and result demonstrability as antecedents to perceived usefulness. The authors named the new model TAM2. Moon and Kim (2001) add perceived playfulness (users' internal belief in WWW acceptance) to the original TAM and they posit that TAM's perceived usefulness and perceived ease of use reflect users' external beliefs. Chen and Tan (2004) extend TAM by adding perceived service quality, perceived trust, and compatibility to the TAM components and they identify product offerings and information richness as antecedents to perceived usefulness. The authors also identify usability of storefront as an antecedent to a perceived ease of use construct.

Childers, Carr and Carson (2001) investigate the influence of hedonic and utilitarian motivations, for online retail shopping, on the TAM model components (i.e., usefulness, ease of use and enjoyment). Childers et al.'s (2001) first study employs three websites which have more focus on hedonic (interactive shopping; high resolution, product images, interactive games and graphics) aspects while the second study focuses on three grocery shopping websites which have more utilitarian aspects. The authors identify navigation (participants' ability to explore, choose and easily navigate through the websites), convenience (users' ability to shop anytime, anywhere), and sub-experience (users' ability to enrich their sense channels while shopping online i.e., technology used to enhance users' senses) as the main antecedents of TAM. Childers *et al.*'s (2001) results reveal that usefulness, ease of use and enjoyment are significant predictors of attitude toward interactive shopping. Navigation is a significant determinant of shopping enjoyment and ease of use. Convenience is a significant predictor of usefulness, ease of use and shopping enjoyment. Substitutability for personal experience is a significant predictor of usefulness and shopping enjoyment. In both studies, enjoyment has a strong predictor of attitude toward interactive shopping. Furthermore, usefulness and enjoyment are equally predictive of interactive shopping attitudes. In the context of the hedonic environment of web shopping, enjoyment is a stronger predictor of attitude than ease of use. However, in a utilitarian environment (study 2), enjoyment and ease of use are equally predictive. Usefulness is a stronger predictor of attitude in the more utilitarian context of online grocery shopping. Unlike Childers *et al.*'s (2001) study, Shang, Chen and Shen (2005) posit that intrinsic and extrinsic motivations are the main antecedents to usefulness and ease of use (TAM model). The result reveals that intrinsic motivations (e.g., enjoyment and fun) are the main reason for consumers to shop online, not the influence of extrinsic motivations (e.g., usefulness). The effect of cognitive absorption was mediated by perceived ease of use. However, usefulness was not the reason for consumers to shop online.

2.9 THE MAIN GAPS IN TELEPRESENCE LITERATURE AND RESEARCH QUESTIONS

Despite widespread discussions and various definitions of VE (Lee, 2004; Li et al., 2001), this thesis notices that previous scholars, within the online retail context, consider the notions of telepresence as virtual substitutes for actual experience with the products. Thus previous marketing literature has focused on defining and conceptualising telepresence virtual experience based on websites' adverts or 3D virtual models. For example, to measure VE, Shih (1998) proposes a conceptual framework to measure telepresence (virtual experience) for the website. Coyle and Thorson (2001) focus on videocassette movies. Klein (2003) employs a simple technology such as Authorware © 3.0 and 4.0, and Hopkins *et al*. (2004) investigate websites VE. On the other hand, other scholars (e.g., Li et al., 2001, 2002, 2003; Fiore et al., 2005a; Suh and Chang, 2006; Yang and Wu, 2009) measured VE based on the 3D telepresence notion. However, this thesis claims that using the notions of 3D telepresence or presence and their definitions, to measure 3D virtual experience are not necessarily wholly appropriate concepts for marketers and website designers. Because (i) these notions represent a process of being mentally transported into other areas or being immersed into an illusion environment, such notions often reflect negative meanings such as immersion, delusion and transportation (Lee, 2004); (ii) presence and telepresence measurement scales, were originally built upon external devices, such as head-mounted display, which are not used in online retailers' 3D virtual model; and (iii) the lack of agreement upon the antecedents of telepresence and presence (interactivity and vividness) often complicates measuring the 3D product visualisation VE. For example, measuring the interactivity concept is a mater of debate (e.g., Ariely, 2000; McMillan and Hwang, 2002; Liu and Shrum, 2002; and Klein, 2003), and the available 3D technology only allows users to use audio and visual cues (vividness). Based on the above gaps, this thesis notices the lack of existing scales that tap the experience of a consumer engaging with an online retailer in a situation where the consumer recognises the 3D product as real. Lee (2004) theoretically argues that none of the previous definitions of telepresence or presence could be used to tap the concept of using virtual environment to reflect the consumers' virtual experience. The author's statement of using "para-authentic objects" to simulate a virtual experience that users can find in real life aspects is worth more investigation. Furthermore, Klein's (2003) notion of realism in the telepresence area, which Klein advised marketers to use, has to have a meaningful effect of telepresence on product beliefs. Also, Lombard and Ditton's (1997) perceptual realism construct which refers to users' perception of objects and people in a virtual world looking, sounding, smelling, and feeling like real people and objects, might be more beneficial for online marketers than the notions of telepresence and presence. Based on Lombard and Ditton's (1997) perceptual realism construct, Lee's (2004) 'para-authentic objects' and Klein's (2003) notion of realism, this thesis proposes a new construct to measure 3D virtual model experience, namely, '3D authenticity', which refers to simulating a real product authentically online. This thesis claims that a 3D virtual experience should be an authentic representation of the direct (offline) experience. The concept of 3D authenticity of the product visualisation implies that ability of the 3D to simulate the product experience in bricks-and-clicks contexts. Recently, new technologies such as augmented reality and Wii technology have been used to enhance users' authenticity experience by virtually interacting with real products:

(i) **Augmented Reality (AR):** Azuma (1997) differentiates between virtual experience (extracted from immersion into the technology such as head-mounted) and augmented reality (AR) such that the later enables users to see real world with virtual objects. Moreover, the author posits three characteristics of the AR. First, AR usually focuses on real and virtual objects. Second, AR enhances a real interaction between the user and the environment. Third, AR should be registered in 3D. Since the AR technology allows users to change the content and form of the real objects, this thesis believes that the real, actual, objects (if illustrated by the AR) can enhance products authenticity.

(ii) **Wii technology:** Wii technology considers another application (such as Nintendo Wii video games) of the virtual reality using 3D technology. Wii technology can be considered as collaboration between human and machine (Bowman et al., 2006). It is a type of immersion where users not only feel that they have been transported into another area, but also they will feel that they are interacting with real agents (Avatars). The notion of authenticity might be applicable into such technology under the circumstances of having a real avatar which represents a virtual agent who is capable to answer users' real questions about real existing products that need more illustrations (this type of authenticity could be named as social authenticity).

Moreover, this thesis claims that using the notion of 3D authenticity is better than using the notion of 3D telepresence. To determine the influences of 3D telepresence and 3D authenticity on consumers' experiences in an online retail context, as stated earlier in section 1.3 this thesis investigates the following research question:

RQ1) How do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?

Previous research in the 3D and 2D product visualisation forms has used different levels of hedonic and utilitarian values to measure how the 2D and 3D forms might impact consumers' knowledge and entertainment. This thesis notices that the previous literature gave the audience general information regarding this issue. In other words, the manipulation levels of hedonic and utilitarian values were not clearly designed. Furthermore, previous research has almost measured 3D perceived knowledge more than the actual knowledge. Although Suh and Lee (2005) reported the ability of 3D products to enhance consumers' knowledge more than 2D products, this thesis claims that if website designers developed proper flashes that can enhance consumers' utilitarian level, then the 3D and 2D products may end up delivering the same information (utilitarian values) to consumers. Moreover, this thesis claims that consumers' ability to zoom in or out, rotate, and change the colour of a 3D flash may end up providing consumers with different levels of hedonic values. Based on the above and as stated earlier in section 1.3, this thesis investigates the following research questions:

> *RQ2) How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailer's website?*
>
> *RQ3) How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailer's Website?*

2.10 SUMMARY

This chapter discussed the extant literature in the immersive virtual reality environment, focusing on the notions of telepresence and presence. Moreover, this chapter explained using the 3D product visualisation in the non-immersive virtual reality, the definitions, antecedents and consequences. This chapter also highlighted the main differences between different human experiences, such as using the 2D and 3D product visualisation forms. Based on the above, this chapter identified some gaps in the literature, particularly within the 3D telepresence area and within the 2D/3D ability to offer online consumers' different types of hedonic and utilitarian values.

Table 2.4 Previous research on online retailers telepresence (virtual experience)

Study	Sample	Stimuli	Methodology design	Telepresence antecedence
Shih (1998)	Conceptual paper	N/A	Conceptual	Vividness (breadth and depth) and interactivity (speed and control)
Coyle and Thorson (2001)	Within-subjects design 68 people (20% students, and 80% adults)	Videocassette movies. Blues music CDs. Women's golf clothing and equipment. Hot sauces.	Four websites with varied levels of interactivity (speed and control) and vividness (breadth and depth)	Vividness (breadth and depth) and interactivity (speed and control)
Li *et al*. (2001)	30 undergraduates surfed four different products.	3D products: Bed, ring, watch, laptop computer.	Protocol analysis (Quantitative).	Virtual experience is vivid, involving, active, affective psychological states
Li *et a*l. (2002)	Study 1 = 60 students Study 2 = 93 UG	3D/2D bed, ring, watch, laptop advertisements	Study = 2 2×2 between-subjects design.	Interactivity and media richness
Li *et al*. (2003)	Study 1= 33 students Study 2= 33 students	3D/2D product type: wristwatch, bedding material and laptops	2×3 mixed design	Interactivity and media richness
Klein (2003)	Non-students: Study 1 = 140 Study 2 = 100	Authorware © 3.0 and 4.0 Study = 1, Wine Study = 2, Face cream	Between-subjects design 2(media richness)× 2(user control)	User control and media richness (full-motion video and audio)
Hopkins *et al*. (2004)	320 undergraduates	Website for the National Arbor Day Foundation	2×2 between-subjects designs factorial design	Media richness
Suh and Lee	85 undergraduates	3D/2D	2×2 factorial design	Interactivity and media

(2005)		Computer table and case	within and between-subjects designs	richness
Fiore *et al*. (2005a)	206 undergraduates	IIT clothes virtual model (High and low levels)	Between-subjects design	Interactivity (modifying the content) and visual vividness
Fortin and Dholakia (2005)	360 actual users divided into nine conditions each has 40 participants	A banner advertisement site	3×3 between-subjects factorial designs	High levels of interactivity (two-way communication) and high levels of vividness (breadth and depth).
Suh and Chang (2006)	240 undergraduates 60 students per each stimulus	Video-clip Multiple-pictures VR 3D.	Between-subjects design	User control and media richness
Yang and Wu (2009)	302 participants: students and non-students	My Virtual Model ™ An advanced IIT website	Online survey	Interactivity and vividness
Keng and Lin (2006)	152 students	Homepage websites	4x2x2 factorial design within and between-subjects designs	High levels of visual imagery (vividness)

Source: Developed for this research (2009)

3 CHAPTER THREE: MODELLING 3D PRODUCT VISUALISATION FOR ONLINE RETAILERS USING THE STIMULUS-ORGANISM-RESPONSE (S-O-R) MODEL

3.1 INTRODUCTION

Online retailers usually provide consumers with certain cues through websites atmospherics. Such cues often affect shoppers' image and experience with the online store (Eroglu *et al.*, 2003). An innovative online retail environment often enhances website atmospherics and it impacts consumers' behaviour. This thesis uses the online Stimulus-Organism-Response (S-O-R) framework to illustrate how using 3D, in the online retailer, impacts the online environmental atmosphere, particularly, consumers' perception and approaches. Section 3.2 explains the offline Stimulus-Organism-Responses (S-O-R) framework theory. Section 3.3 describes the online S-O-R framework. Section 3.4 explains the main gaps in previous online S-O-R frameworks. Section 3.5 proposes a new combination of the S-O-R model using 3D product visualisation.

3.2 THE S-O-R THEORY ON BRICK-AND-MORTAR ATMOSPHERICS

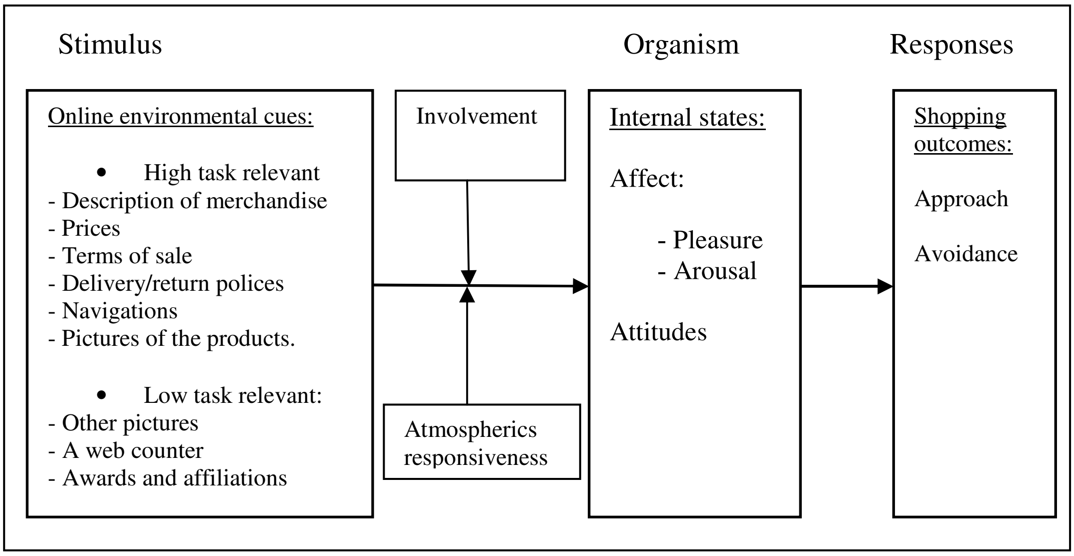
The concept of a retailer's environment has evolved and established from the area of environmental psychology (Turley and Milliman, 2000). Originally the S-O-R model was established by Mehrabin and Russel (1974) who investigate the effects of the physical environment on human behaviour using three-dimensions: Pleasure, Arousal, and Dominance (PAD). The authors introduce the PAD concept to suit different environments. Related to environmental psychology is the concept of atmospherics which was introduced by Kotler (1973-1974, p. 50) as "*the conscious designing of space to create certain buyer effects, specially, the designing of buying environments to produce specific emotional effects in the buyer that enhance purchase probability*". To that end, Donovan and Rossister (1982) discover the impact of the retail atmosphere on various psychological and behavioural shopping outcomes via testing empirically the S–O–R framework in retail store environments. The authors examine Mehrabin and Russel's (1974) scale, which presents a theoretical model for studying the effects of the physical environment on human behaviour, using the three PAD dimensions. Donovan and Rossister's (1982) findings posit that retail environmental stimuli (S) impact consumer emotional states (O), which result in approach or avoidance behaviours (R) in respect of the store.

Considerable research, after Donovan and Rossister's (1982) retail atmosphere theory, investigates the impact of a specific atmospheric cue, or investigates the impact of an offline store atmosphere as a whole on shopping behaviour. For example, Donovan and Rossister (1982) investigate the impact of store atmosphere on the time that consumers spend in the store. Golden and Zimmer (1986) examine the effect of store atmosphere on future patronage. Baker (1992) proposes a general typology for elements of a store environment (i.e., social factors, design factors and ambient factors) that affect customer responses. However, Bitner (1992) presents a model that focuses on the impact of physical surroundings (e.g., ambient, space, functionality, symbols, and artifacts) on the behaviour of customers and employees. Mattila and Wirtz (2001) posit that customers rate retail environment more positively when ambient scent and music are congruent in terms of their levels, which end up enhancing the shopping experience. Notwithstanding, Eroglu *et al*. (2001) and Manganari *et al*. (2009) posit that offline store atmospherics usually do not entirely apply on the virtual retail atmospherics. Therefore, many studies have been conducted in the area of e-retailers following the online S-O-R framework.

3.3 THE S-O-R FRAMEWORK ON ONLINE RETAILERS

In the field of online shopping many researchers (e.g., Eroglu *et al*., 2001; 2003; Richard 2005; Sautter *et al*., 2004) use the S-O-R framework and focus on the overall online store environment especially atmospheric qualities (see Table 3.1). Dailey (2004, p. 796) defines web-atmospherics as "*the conscious designing of web environments to create positive effects in users in order to increase favourable consumer responses*". With respect to the previous studies on this area, few have tested the influence of one stimulus alone. Previous studies investigate the impact of the whole environment (using many stimuli) on consumers' responses. The following studies illustrate the effects of online atmospherics on consumers' responses using the online S-O-R model. For example, Eroglu *et al*. (2001, 2003) investigate the effect of online atmospheric cues (S) on shoppers' emotional and cognitive states (O), which then affect their shopping outcomes (R). The authors classify online environmental cues into high task relevant (i.e., utilitarian cues) and a low task relevant (i.e., hedonic cues). In the organism state (O) the authors test the affective and cognitive variables and find that Mehrabian and Russell's (1974) PAD does not capture the range of organic reaction to shopping environments in an online context (see Figure 3.1)

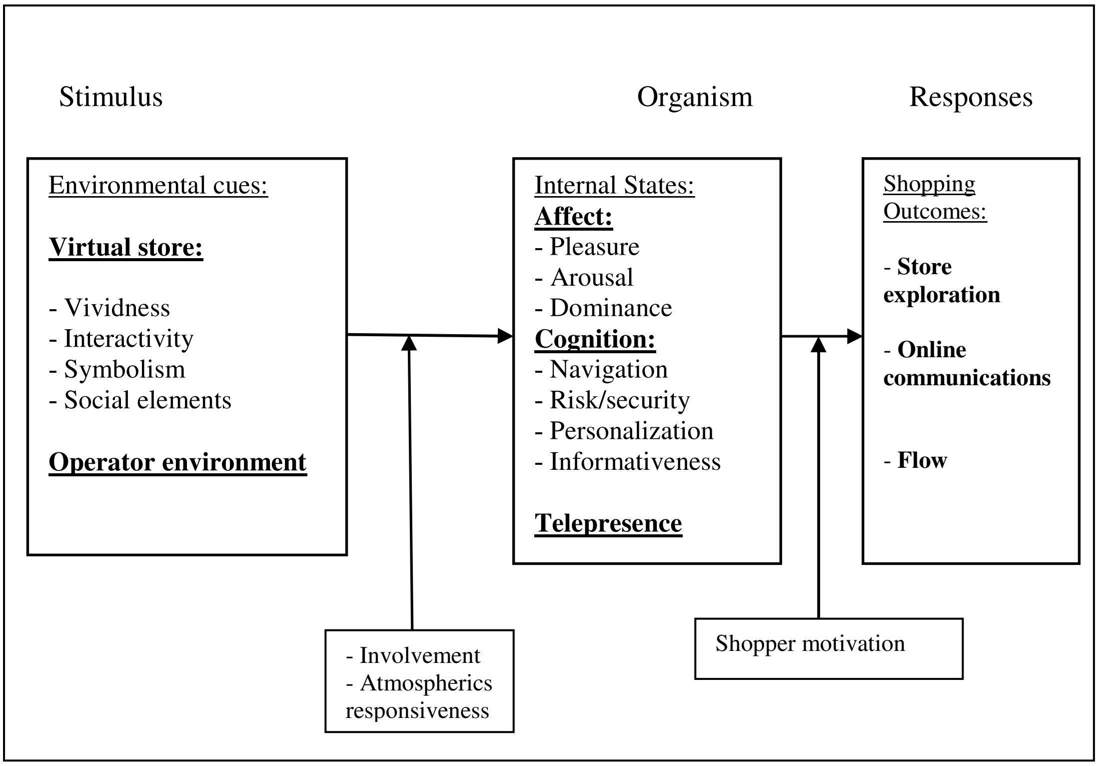
Figure 3.1 The S-O-R model of consumer response to online shopping.



Source: Eroglu *et al*. (2001, 2003)

To that end, Sautter *et al*. (2004) critically analyse Eroglu *et al*.'s (2001; 2003) framework and argue that the Eroglu *et al*. (2003) study simplifies the structure of online cues and fails to integrate important contributions from other areas of online research. Sautter *et al*. (2004) extend Eroglu *et al*.'s (2001; 2003) framework and introduce the concept of dual environment, which includes; (i) the online store environment (i.e., the online social element and symbolism environment) and (ii) the operator environment (i.e., human-computer-interaction environment) to the stimulus part. The authors identify vividness (i.e., information presented to human senses), interactivity (i.e., control and navigation), symbolism (i.e., traffic counter) and social elements (i.e., shopping agents, and online communities) as the main stimuli that online atmospherics provide to users. In the organism part (O), the authors suggest telepresence, consumers' affective and cognitive constructs. In the responses part (R), the authors posit three constructs; store exploration, online communications and flow (see Figure 3.2).

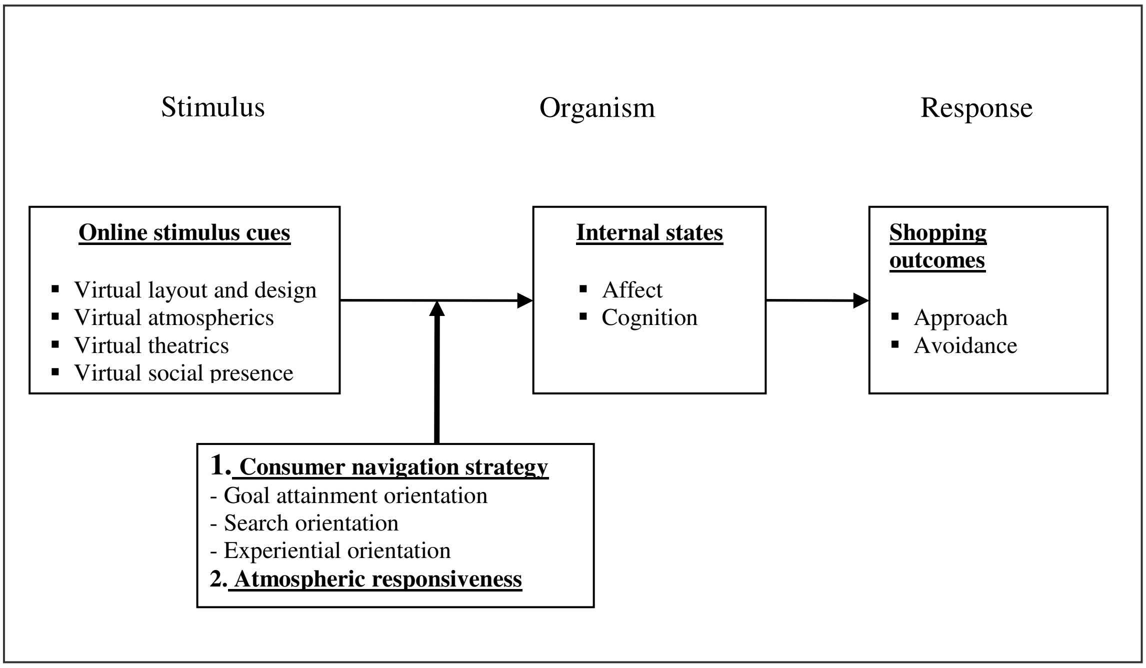
Figure 3.2 The S-O-R model of e-tail atmospherics.



Source: Sautter *et al*. (2004)

In line with Sautter *et al*. (2004), Manganari *et al*. (2009) investigate the theoretical effects of online store atmosphere on consumer behaviour. The authors' conceptual framework reveals that virtual layout and design (grid layout, free-form layout, racetrack layout), virtual atmospherics (background colour, colour scheme, percentage of white space, background music, fonts, scent appeal), virtual theatrics (animation techniques, images, vividness and interactivity), and virtual social presence (web counter, comments from other visitors, crowding) are the main stimuli that an online retailer should have to enhance online store environment. In the organism part (O), Manganari *et al*. (2009) suggest using the affective and cognitive constructs. In the responses part (R), Manganari *et al*. (2009) propose approach avoidance as the main shopping outcomes (see Figure 3.3).

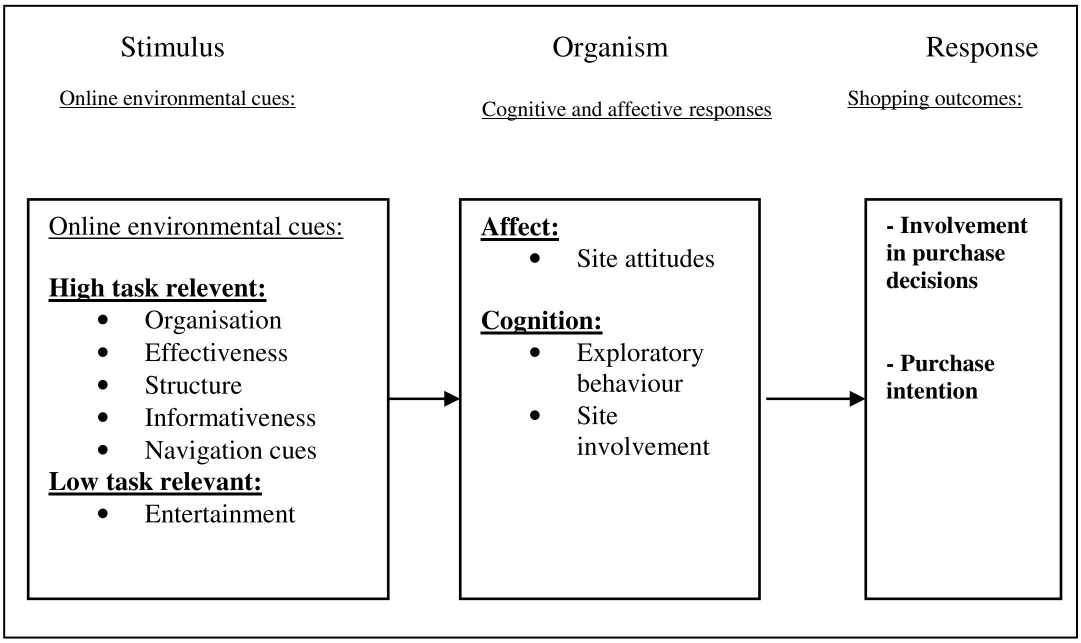
Figure 3.3 Conceptual model of consumers' responses to the online store environment.



Source: Manganari *et al*. (2009)

Richard (2005) extends Eroglu *et al*.'s (2003) model and classifies stimuli (S) for the healthcare sector into high task relevant and low task relevant. The former includes: navigation, informativeness (i.e., useful site), information content effectiveness (i.e., information is up-to-date/accurate), site structure (i.e., well organised), and organisation (i.e., not confusing). However, the low task relevant includes entertainment sites (i.e., exiting/imaginative). Richard classifies the organism part (O) into two categories: cognition (measured by exploratory behaviour and site involvement) and affective (measured by site attitude, see Figure 3.4). In the responses part (R), the authors investigate two constructs: involvement and purchase intention.

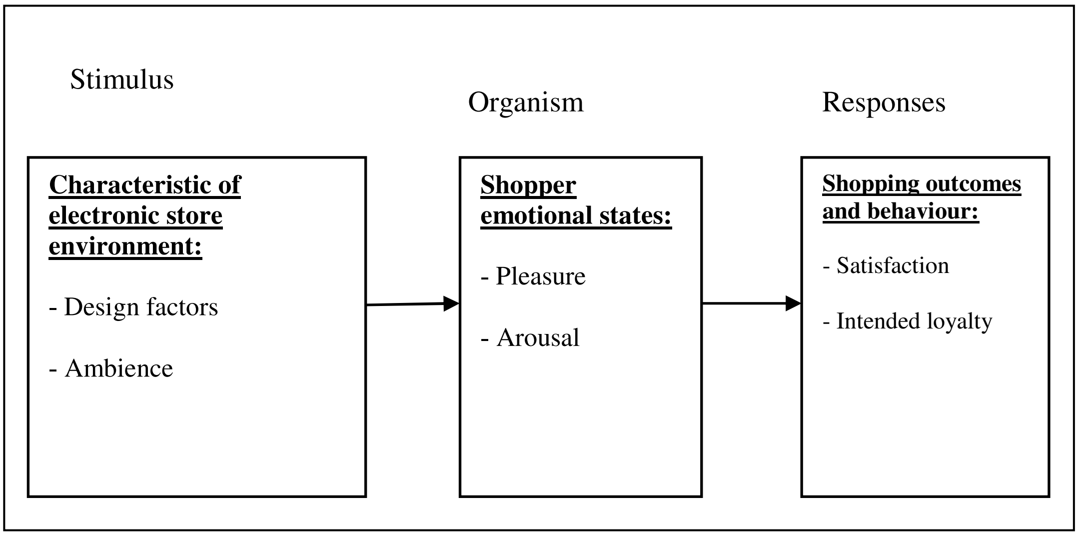
Figure 3.4 The S-O-R model of the impact of internet atmospherics on surfer behaviour.



Source: Richard (2005)

Mummalaneni (2005) carries out an online study using the S-O-R framework (Figure 3.5). The author classifies website characteristics (design and ambient factors) of online apparel footwear stores, as the stimulus part (S). In the organism (O) part, this uses only the emotion construct and applies Mehrabian and Russell's (1974) pleasure and arousal scale (but not dominance). In the responses part (R), the authors investigate two constructs: satisfaction and intended loyalty. With respect to Mummalaneni's (2005) study, many authors in the online environment (e.g. Sautter *et al.*, 2004; Richard, 2005; Demangeot and Broderick, 2007) have focused on the important role of cognition in the organism state (O). Other scholars such as Eroglu *et al.* (2003) posit that the PAD theory does not properly fit into the online S-O-R context.

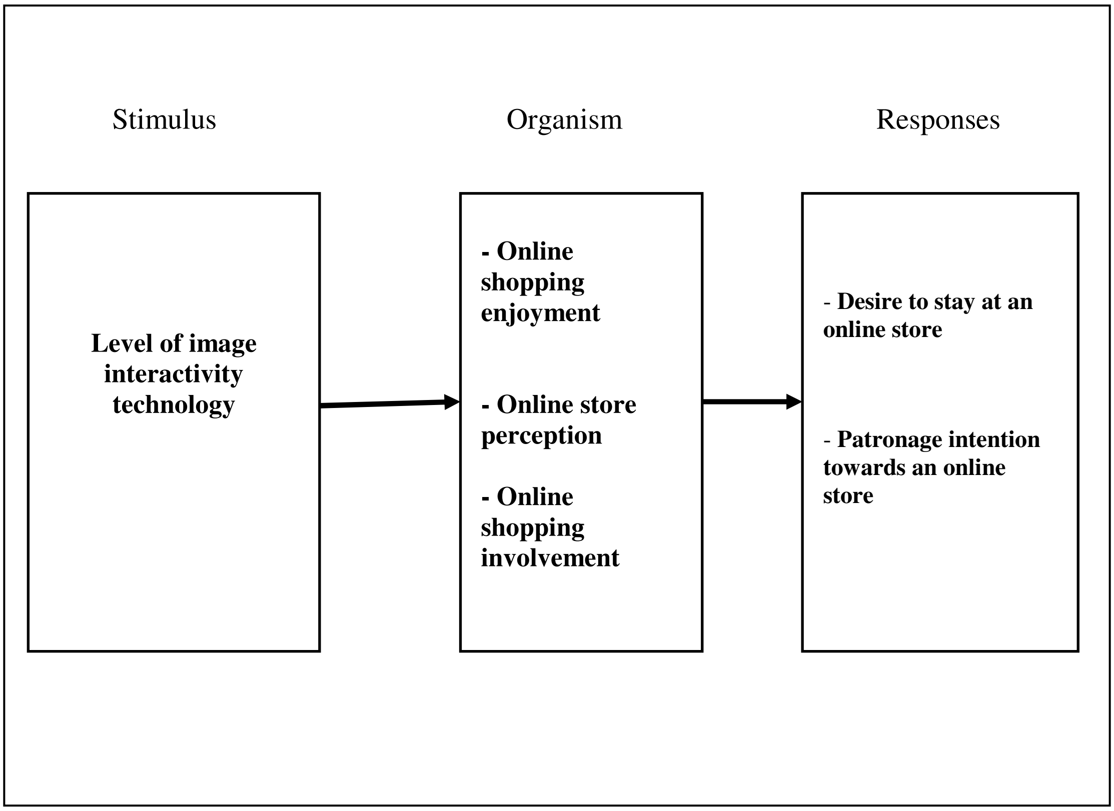
Figure 3.5 The effects of online store environmental characteristics on shopping behaviour.



Sources: Mummalaneni (2005)

The previous literature on the online S-O-R framework concerns mainly investigations of the effect of whole website atmospherics, but not the effects of a specific element, on consumers' responses. Some studies investigate the effects of a specific cue on the online retailer but such studies did not consider the online S-O-R model. For instance, Lee and Benbasat (2003) posit that fidelity and motion of images keeps customers for longer in a website. McKinney (2004) asserts that atmospheric variables, such as graphics and photos, influence customers' satisfaction. To address the issue of investigating a specific cue using the online S-O-R model, Kim *et al*. (2007) investigate the effects of different levels of image interactivity technology (IIT) on consumers' approach responses. The authors find that a high level of IIT (3D virtual model) enhances users' responses towards the online retailer (i.e., desire to stay and patronage intention to the online retailer). The 3D virtual model provides participants with high levels of enjoyment, involvement and online store perceptions in comparison to image enlargement technology (a low level of IIT). (See Figure 3.6).

Figure 3.6 S-O-R model: A theoretical model predicting online retailer patronage behaviour.



Source: Kim *et al.* (2007)

3.4 THE MAIN GAPS IN PREVIOUS ONLINE S-O-R FRAMEWORKS

The environmental cues in Eroglu *et al.*'s (2003) study simplify the structure of online cues and fail to integrate important contributions from other areas of online research (Sautter *et al.*, 2004). In turn, Sautter *et al.*'s (2004) and Manganari *et al.*'s (2009) models theoretically suggest the addition of interactivity and vividness to the stimulus part. Such a suggestion evolved from the ability to create an atmosphere that often enhances customers' ability to feel the products on retailers' websites. In addition, Sautter *et al.*'s (2004) model proposes the addition of telepresence in the organism part, a suggestion which is worth investigation because interactivity and vividness may represent the main antecedents of the telepresence construct. Unfortunately, both Sautter *et al.*'s (2004) and Manganari *et al.*'s (2009) models were not empirically tested and there is no evidence or clear cut opinion about the nature of the proposed relations, or how they might impact each other. For example, the Sautter *et al.*'s

(2004) model did not explain the process by which telepresence influences the internal state (i.e., the affective and cognitive parts).

An in depth look at the previous studies reveals that they all investigate the impact of the online environment on consumers' responses, particularly by focusing on web atmospheric cues in general, without studying the impact of a specific cue in an online website. Dailey (2004) posit that previous studies focused on general web atmospheric cues, rather than on a specific cue, decrease the likelihood of finding theories that properly illustrate the way such cues may impact consumers. Even though Kim *et al.*'s (2007) study was the first to investigate the impact of 3D image interactivity technology on consumers' responses using the online S-O-R framework. This study ignores the influence of virtual experience as an important variable in the virtual product virtualisation context. Many scholars (e.g., Fiore *et al.*, 2005a; Li *et a*l., 2001; 2002; 2003) have highlighted the importance of 3D virtual models, in a mediated-computer environment, to create a virtual experience, enhance emotions or involvement and increase responses toward retailers' websites.

In the previous chapter, this thesis has explained that interactivity and vividness may represent the main determinants of 3D virtual experiences (Biocca and Delany, 1995; Heeter, 1992; Lombard and Ditton, 1997; Sheridan, 1992; Steuer, 1992; Witmer and Singer, 1998). However, there is little agreement on the definition or operationalisation of the interactivity construct (e.g., Ariely, 2000; Klein, 2003; Liu and Shrum, 2002; McMillan and Hwang, 2002). Moreover, previous studies reveal that some authors use interactivity and vividness as antecedents of 3D telepresence experience (e.g., Fortin and Dholakia, 2005; Suh and Chang 2006; Suh and Lee, 2005), whereas others use vividness only (e.g., Hopkins *et al.*, 2004). Still other authors consider interactivity and vividness as the main indicators of 3D telepresence virtual experience (e.g., Kim *et al.*, 2007; Song *et al.*, 2007) but not its antecedents. Furthermore, this thesis has claimed the importance of using an authentic 3D (to represent VE) instead of 3D telepresence. On that basis, this thesis claims that 3D telepresence and its abstract antecedents are not suitable terminologies for marketers to use because they reflect a feeling of being transported, immersed and deluded into an inaccessible environment. Instead, this thesis proposes the notion of 3D authenticity and its antecedents (control and animated colours) to reflect the authentic representation of real products. To test the influences of different levels of 3D antecedents (control and animated colours) on 3D authenticity, as stated earlier in section 1.3, this thesis raises the following research question:

> *RQ4) How do different levels of 3D control and animated colours influence 3D authenticity?*

Extant literature reported hedonic and utilitarian values as the main consequences of using 3D product visualisation. Notwithstanding, this thesis noticed that previous researchers neither discovered the impact of different levels of hedonic and utilitarian values on behavioural intention, nor their interaction effects. Therefore, as stated earlier in section 1.3, this thesis raises the following research questions:

> *RQ5) How do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?*

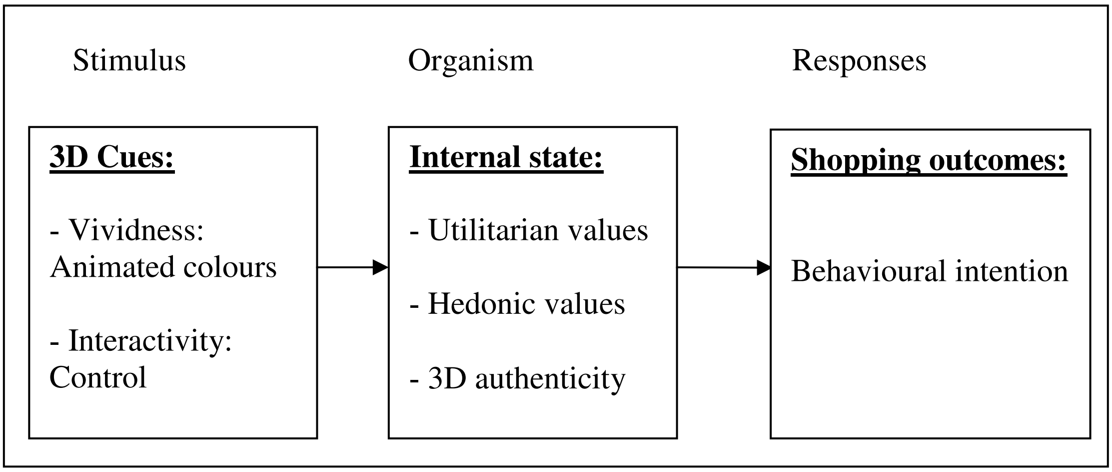
3.5 PROPOSED S-O-R FRAMEWORK

Building upon Kim *et al.*'s (2007) study, this thesis investigates the effect of 3D product visualisation on a website atmospheric. The addition of a new notion, namely, 3D authenticity to the organism part (O) and the antecedents of 3D authenticity (the main parts in the stimulus part), distinguish this study from previous research that has studied the impact of a specific cue, such as music, graphic, photos, and product presentation on a website atmospherics. Moreover, building upon Sautter *et al.*'s (2004) and Manganari *et al.*'s (2009) theoretical models, this study felt that it is important to measure how consumers within the online retail context could imagine that 3D presented products. Particularly, this study introduced a new construct, namely 3D authenticity to reflect customers' virtual experience, where customers can feel the authenticity of the 3D products.

This thesis expects that this addition will help to explain customers' hedonic and utilitarian values within the organism part of the online S-O-R model.

Based on the above gaps in the previous research that has extended the online S-O-R model, and since only one study has used the online S-O-R framework to illustrate consumers' perceptions and their responses toward online retailers' environment, the current research proposes the following framework to measure the impact of 3D product visualisation on consumers' perceptions and responses. To fill the gaps in the online S-O-R framework, this study proposes the following constructs in each state.

Figure 3.7 A proposed framework for 3D cues on an online virtual environment.



Source: The author (2009)

The above framework describes the main cues that 3D product visualisation provide to consumers when navigating an online retailer. Moreover, the Organism part explains the main theories which will help this thesis to determine why the above cues may influence consumers' responses. The conceptual framework chapter explains the proposed relationships and the main theories behind using them. As stated earlier in section 1.3, this thesis raises the following research question: using the Stimulus-Organism-Response framework:

> *RQ6) How do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?*

3.6 SUMMARY

This chapter reviewed the S-O-R framework both offline and online. Moreover, this chapter critically analysed the online S-O-R framework and stated the main gaps and problems. Based on the identified gaps in Chapter 2, this chapter proposed a new online S-O-R framework which focuses on control and animated colours (the main component in the stimulus part), 3D authenticity, hedonic and utilitarian constructs in the organism part, and behavioural intention in the response part. Chapter 4 explains the proposed model and hypotheses.

Table 3.1 Key studies on the online S-O-R store atmosphere.

Author	Independent variable (S)	Mediators (O)	Dependent variable (R)
Eroglu et al. (2003)	**High task:** -Description of merchandise - Prices - Terms of sale - Delivery/return polices - Navigations - Pictures of the products. **Low task:** - Other prices - A web counter - Awards and affiliations	**Affect:** -Pleasure -Arousal **Attitudes**	Satisfaction Approach Avoidance
Sautter et al. (2004)	**Virtual store:** -Vividness -Interactivity -Symbolism -Social elements **Operator environment** Human-computer interaction	**Affect:** -Pleasure -Arousal -Dominance **Cognition:** -Navigation -Risk/security -Personalization -Informativeness **Telepresence**	- Store exploration -Online communications - Flow
Richard (2005)	**High task:** -Organisation -Entertainment -Structure -Informativeness -Navigation cues **Low task:** -Entertainment	**Affect:** -Site attitudes **Cognition:** -Exploratory behaviour -Site involvement	-Involvement in purchase decisions -Purchase intention
Mummalaeni (2005)	- Design factors. - Ambience	**Shopper emotional states:** - Pleasure - Arousal.	- Satisfaction - Intended loyalty
Kim et al. (2007)	- Level of image interactivity technology	**Online shopping enjoyment** **Online store perception** **Online shopping involvement**	-Desire to stay at an online store -Patronage intention towards an online store
Manganari et al. (2009)	-Virtual layout and design -Virtual atmospherics -Virtual theatrics -Virtual social presence	**Internal States** -Affect -Cognition	-Approach -Avoidance

Source: Developed for this research (2009)

4 CHAPTER FOUR: FRAMEWORK AND HYPOTHESES DEVELOPMENT

4.1 INTRODUCTION

Chapter Four discusses the main constructs in this thesis: the proposed hypotheses and the development of a conceptual framework. Section 4.2 explains the notion of telepresence in immersive and non-immersive (i.e., online retailers) virtual reality environments. Section 4.3 explains the notion of 3D telepresence and its antecedents in these virtual reality environments. Section 4.4 clarifies the notion of 3D authenticity and its definition explanation. Section 4.5 discusses the 3D and 2D virtual experiences. Section 4.6 explains the effects of the progressive levels of control and animated colours on the 3D authenticity construct. Section 4.7 explains the effects of the progressive levels of hedonic and utilitarian values on the behavioural intention construct. Finally, using the online Stimulus-Organism-Responses (S-O-R) framework, Section 4.8 discusses the impact of the Stimulus part (S) constructs (control and animated colours) on the Organism part (O) constructs (3D authenticity, hedonic and utilitarian values), and the influence of the Organism part (O) constructs on the Responses part (R) construct (behavioural intention).

4.2 TELEPRESENCE IN THE IMMERSIVE AND NON-IMMERSIVE VR

VR terminologies enter the vocabulary with the emergence of IVR devices, such as the head-mounted display, which allow users to interact with virtual environments and to visualise different objects (Suh and Lee, 2005). As a result, the notions of telepresence or presence emerge. Notwithstanding, previous literature in the IVR area has provided readers with different classifications and conceptualisations of VR. For example, Steuer's (1992, p. 76) definition of VR focuses on human experience, not technological hardware, and differentiates between presence and telepresence. Whereas presence refers to "*the experience of one's physical environment, it refers not to one's surroundings as they exist in the physical world, but to the perception of those surroundings as mediated by both automatic and controlled mental processes*", telepresence is "*the experience of presence in an environment by means of a communication medium*". In turn, Sheridan (1992) distinguishes between virtual presence and telepresence, such that presence relates to the sense of being in a computer-mediated environment, whereas telepresence indicates a sense of being in any real remote location. To that end, Biocca and Delaney (1995) argue that the definition of VR depends on technological hardware and software. The authors define VR as perceptual immersion presence. This type of presence depends on sensory immersion in virtual environments. To extend prior literature, Lombard and Ditton (1997) identify six taxonomies of VR presence experiences: social richness, realism, transportation, immersion, social actor within medium, and medium as social actor. Notwithstanding Lombard and Ditton's (1997) classification, two types of presence experience are identified in the NIVR area, concerning users interaction with e-retailers' websites and products using desktop or laptop computers (Suh and Lee, 2005). The first is telepresence virtual experience, or the illusion of being in a place far from the physical body (Biocca, 1997; Heeter, 1992). This conceptualisation of telepresence virtual experience relates to transporting a user, self, or place, to another place. The second form is telepresence virtual experience in a social sense, such that other beings exist in the VR world with whom users can interact (e.g., avatars). Authors such as Heeter (1992) and Lombard and Ditton (1997) empirically test this concept, McGoldrick and colleagues (2008), and Wang and colleagues (2007) emphasise the avatar's role in enhancing virtual personal shopper capabilities.

4.3 3D TELEPRESENCE ANTECEDENTS IN IMMERSIVE AND NON-IMMERSIVE VR

Interactivity and vividness may represent the main determinants of telepresence within IVR (Biocca and Delany, 1995; Heeter, 1992; Lombard and Ditton, 1997; Sheridan, 1992; Steuer, 1992; Witmer and Singer, 1998). Interactivity appears particularly of interest since the appearance of communication channels such as the World Wide Web, for which it represents a critical concept and primary advantage (Morris and Ogan, 1996; Rafaeli and Sudweeks, 1997). Considerable research investigates and empirically tests the construct, but there is little agreement on the definition or operationalisation of the interactivity construct (e.g., Ariely, 2000; Klein, 2003; Liu and Shrum, 2002; McMillan and Hwang, 2002). For example, Steuer (1992) classifies it into three elements: speed, mapping and range. Rafaeli (1988) and Rafaeli and Sudweeks (1997) argue interactivity relates to the communication process, and Ariely (2000) defines it on the basis of the control construct (the narrowest definition). Wu (1999) relies on the self-efficacy construct, whereas Rowley (2008) focuses on information interactivity. Still other scholars (e.g., Downes and McMillan, 2000; Lui and Shrum, 2002; McMillan, 2002; McMillan and Hwang, 2002) argue that definitions of interactivity cannot be restricted to messages, human interactions or communications but rather should include multidimensional aspects. Thus, speed, responsiveness and communications represent the main elements to define and measure interactivity antecedents. In contrast, vividness, according to Steuer (1992, p. 81) is "*the way in which an environment presents information to the senses*". Steuer explains that vividness is stimulus driven and depends completely on the technical characteristics of a medium. In turn, it represents a product of two important variables: sensory breadth and sensory depth. Most scholars use this definition of vividness.

Previous research on IVR (e.g., Biocca, 1997; Heeter, 1992; Lombard and Ditton, 1997; Sheridan, 1992) reveals several key findings. First, researchers from different fields (e.g., communication, business, psychology, and HCI) use different terms (e.g., presence, telepresence, virtual presence, immersion, and mediated presence) to describe the same concept. However, some debate remains regarding definitions of presence and telepresence. Second, previous research uses presence and telepresence to explain VR experience, though these conceptualisations have depended on the level of technology (e.g., Biocca, 1992; Steuer, 1992; Sheridan, 1992). Whereas, in the past, researchers used display interface technologies such as goggles, head-mounted visors, data gloves, joysticks, head trackers, and televisions to identify and measure telepresence (e.g., Biocca, 1992; Heeter, 1992; Lombard and Ditton, 1997; Sheridan 1992; Steuer, 1992; Witmer and Singer, 1998), more recent technological developments can transport users to other places, where they can see and interact with other intelligent beings (e.g., avatars in Second Life, chat rooms, online communities), without forcing them to wear technological devices. To address this issue, online retail literature introduces the NIVR environment and explains the main antecedents of a web telepresence, and 3D product visualisation telepresence. For example, in conceptualising consumer experiences in cyberspace, Shih (1998) posits that the vividness of the information (operationalised as multi-sensory information, i.e. breadth and depth) a consumer receives in cyberspace and the interactivity of the cyberspace technology (operationalised as control, speed and feedback) provide the main antecedents of a web telepresence (i.e., being there). In turn, Coyle and Thorson (2001) investigate the effects of progressive levels of interactivity and vividness on web marketing sites by manipulating levels of interactivity (number of choices and presence of a clickable image) and vividness (audio and animation). They find that high levels of interactivity and vividness increase participants' feelings of "being there" (i.e., telepresence virtual experience). Fortin and Dholakia's (2005) empirical research reveals the direct and indirect impacts of interactivity (degree of control, response time) and vividness (breadth and depth of the message, colours, graphics, quality, and resolution) on social presence virtual experience (i.e., being there). High levels of interactivity and vividness have significant impacts on perceived social presence. According to Klein (2003), Macromedia's Authorware© 3.0 and 4.0 represent simple technology and thus provide another means to examine the effects of telepresence virtual experience (being transported into another area) on consumer responses. Moreover, Klein (2003) finds that interactivity (user control) and media richness (breadth of sense channels) emerge as the main antecedents of telepresence, with significant positive influences on its creation.

Thus, previous studies of NIVR reveal that some authors use interactivity and vividness as antecedents of telepresence (e.g., Fortin and Dholakia, 2005; Suh and Chang 2006; Suh and Lee, 2005), whereas others consider vividness only (e.g., Hopkins *et al.*, 2004). However, other authors consider interactivity and vividness the main indicators of telepresence (e.g., Kim *et al.*, 2007; Song *et al.*, 2007) but not its antecedents. Empirical tests of the influence of 3D on consumer experiences (e.g., Li *et al.*, 2002; Suh and Lee, 2005; Hopkins and colleagues, 2004 and Suh and Chang, 2006) indicate that 3D product simulations (the best user interface for enhancing telepresence) have direct and indirect impacts on product knowledge, product attitude, brand attitudes, and purchase intentions.

These studies imply that interactivity and vividness are the main antecedents of telepresence. On that basis, this thesis claims that 3D telepresence and its abstract antecedents are not the suitable terminologies that marketers should use because they reflect a feeling of being transported, immersed, and deluded into an inaccessible environment. Instead, this thesis proposes the notion of 3D authenticity and its antecedents (control and animated colours), reflecting the authentic representation of real products.

4.4 3D AUTHENTICITY CONSTRUCT

None of the previous definitions of telepresence or presence that use 3D virtual models realistically taps consumers' virtual experiences. A 3D virtual experience should be an authentic representation of the direct (offline) experience. This thesis, therefore, proposes a new notion that relates to the simulation of an online product and virtual experience; namely, the authenticity of the 3D product visualisation. Telepresence and presence are not particularly well suited to the online retail context, because they reflect illusion, immersion and transportation to other places. In contrast, the concept of 3D authenticity of the product visualisation implies that ability to simulate the product experience in bricks-and-clicks contexts. This study proposes the following definition of perceived authenticity in a computer-mediated environment: 3D Authenticity is a "*psychological state in which virtual objects presented in 3D in a computer-mediated environment are perceived as actual objects in a sensory way*". The main goal of this definition is to explain the authenticity of a 3D product visualisation for online retailers rather than any other technological ideas.

4.4.1 Definition Explanation

To achieve an authentic state of a 3D product visualisation, online retailers must consider product attributes and consumer goals. Consumer goals refer to subjective characteristics (i.e., internal factors) such as users' perceptual and cognitive states, and often help users to determine the motivations for using a 3D visualisation in any retailer's website (i.e., to get more information about the product or to have fun). In turn, products attributes describe the 3D objective characteristics (i.e., external factors, according to Lee, 2004; Steuer, 1992).

External factors often help users to perceive objects and entities in their virtual environment as if they are real. A 3D ability to enhance the product form (i.e., enhancing sensory information) and to present the product content (e.g., explaining product characteristics, seeing the product from different angels, and being able to change the product's shape or colours) often helps users to perceive the 3D product visualisation as real (Klein, 2003; Lee, 2004).

Unlike previous definitions of telepresence or presence, the 3D authenticity construct definition avoids words, such as illusion, because this may create undesirable feeling about the virtual experience (Lee, 2004). Furthermore, the 3D authenticity definition excludes the notion of illusion because consumers can find the illustrated 3D products in a retailer's website and in an offline store (i.e., consumers are not escaping their real world). Moreover, the 3D authenticity definition avoids using the notion of immersion because consumers can not use all their senses while navigating a 3D product visualisation in an online retailer's website. Even though 3D visualisation in online retailers can enrich visual and audio sensations for the time being, it does not provide tactile and smelling sensations (Kim and Forsythe, 2008). Also, the 3D authenticity construct is not a process of being mentally transported into other places because it does not temporarily eliminate users' surroundings and, in turn, users do not feel the departure or arrival to or from one place to another. Based on the definition of authenticity, this thesis recommends the following guidelines to evaluate the authenticity of 3D products:

(i) The notion of authenticity is all about the psychological state of seeing the virtual product as a real product in a sensory way. To achieve this state, the 3D flash should be highly interactive (i.e., users can modify the content and form of the 3D flash), vivid (i.e., users should have the ability to change the colour of the product and hear the sound of the product, if available) and it should enable users to feel and think that they are interacting with a real product which they can find in high street shops.

(ii) Authenticity is all about products that consumers can find both online and offline.

(iii) The main purpose of the authenticity construct is about enhancing the consumers learning process. In other words, an authentic 3D product should enhance users' ability to learn and virtually interact with products online. Doing this will enhance users' imagination about interacting with the product just as if they are shopping in an offline retailer.

(iv) Authenticity should enhance users' understanding of the products' features, attributes (actual information) and appearance (perceived knowledge).

To determine the influences of 3D telepresence and 3D authenticity on consumers' virtual experience in an online retail context, this study adopts Lee's (2004) theoretical argument, Klein's (2003) notion of realism and Lombard and Ditton (1997) perceptual realism constructs. Lee (2004) suggests that none of the previous definitions of telepresence or presence can be used to tap the concept of using a virtual environment to reflect the consumer experience. Lee (2004) advices scholars to focus on the notion of "para-authentic objects" to simulate a virtual experience of products that users can find in real life aspects. Furthermore, Klein (2003) directs marketers to use the notion of realism to have a meaningful effect of a product visualisation on product beliefs. Also, Lombard and Ditton (1997) recommend using the notion of perceptual realism to describe users' perception of objects and people in a virtual world as real people and objects. Based upon the "para-authentic objects", realism and perceptual realism constructs, this thesis considers using the 3D authenticity construct instead of the notion of telepresence (i.e., being there, illusion or immersion). On the basis of the previous definitions of 3D telepresence and this thesis definition of the 3D authenticity construct, this thesis posits that:

H_1: On the online retailer's website, 3D authenticity has a greater effect on users than does 3D telepresence.

4.5 3D AND 2D EXPERIENCES

Previous research on the 3D virtual models and 2D static pictures (Kim and Forsythe, 2007, 2008; Kim and Biocca; 1997; Li *et al*., 2003; Suh and Lee, 2005) report the importance of 3D product visualisations to enhancing consumer learning in the online retailer. For example, Kim and Forsythe's (2007) study finds 3D product visualisation as a richer source of entertainment and fun than 2D static pictures. In addition, Kim *et al*. (2007) posit that a high level of 3D product visualisation enhances consumers' enjoyment more than 2D static pictures. Kim and Forsythe's (2008) empirical result reveals that 3D virtual models and 2D static pictures produce functional roles. A 3D rotation view has two roles; functional, and hedonic with slightly higher functional role. The authors assert that, compared with 3D, 2D has a more functional role than hedonic. Jiang and Benbasat (2007. p, 478) point out that the 2D static picture and 3D product visualisation presentation forms equally provide the same actual knowledge (i.e., the extent to which consumers actually understand product information) when a consumer seeks the utilitarian information about a high task complexity product (such as a laptop). In turn, Suh and Lee (2005) report the ability of 3D products to enhance consumers' knowledge more than 2D products. Notwithstanding, this study believes that if a website retailer designs the 3D flash in a way that provides consumers with the essential information they seek, then 3D product visualisations and 2D static sites can deliver the same information to consumers. In other words, this thesis claims that if 3D and 2D presentation forms provide consumers with the same information, then consumers will not go and search (read) more information form the static site. Therefore, this thesis hypothesises:

> *H_2: Compared to static pictures (2D) in a retailer website, 3D visualisation produces different hedonic value for consumers.*
>
> *H_3: Compared to static pictures (2D) in a retailer website, 3D visualisation produces the same utilitarian value for consumers.*

4.6 THE EFFECTS OF PROGRESSIVE LEVELS OF CONTROL AND ANIMATED COLOURS ON 3D AUTHENTICITY

Previous research on 3D product visualisation (e.g., Coyle and Thorson, 2001; Kline, 2003) reports the importance impact of high levels of user control and animated colours on users' beliefs about a product realism. Low levels of user control and animated colours often reduce users' ability to feel the authenticity of the presented products. Therefore:

> *H_4: 3D authenticity will increase as levels of user control and animated colours in a retailer's website increase.*

4.7 THE EFFECTS OF PROGRESSIVE LEVELS OF 3D HEDONIC AND UTILITARIAN VALUES ON BEHAVIOURAL INTENTION

The importance impact of 3D experiential and instrumental aspects on behavioural intention has been reported by many studies (e.g., Fiore *et al.*, 2005a, 2005b) that have investigated the impact of 3D hedonic and utilitarian values on consumers' responses. Notwithstanding, the previous studies have not investigated the impact of the different levels of 3D hedonic and utilitarian values on behavioural intention. On that basis, this study hypothesises:

> *H_5: Behavioural intention towards the online retailer will increase as levels of 3D hedonic and utilitarian values increase.*

4.8 CONCEPTUAL FRAMEWORK

Using the online S-O-R framework often enables marketers to understand consumers' responses. Moreover, focusing on a single cue, within the online S-O-R framework, usually helps marketers to build proper theories in the field (Dailey, 2004). Previous studies (e.g., Eroglu *et al.*, 2003; Manganari *et al.*, 2009; Mummalaneni, 2005; Sautter *et al.*, 2004; Richard, 2005) on the area of online S-O-R reveal some important gaps that have not been bridged yet. For example, Eroglu *et al.*'s (2003) study simplifies the structure of online cues and fails to integrate important contributions from other areas of online research (according to Sautter *et al*., 2004). Sautter *et al*.'s (2004) and Manganari *et al*.'s (2009) models were not empirically tested and there is no clear cut opinion about the nature of the proposed relations or how they might impact each other. Moreover, previous literature on online S-O-R frameworks concerns mainly investigations of the effect of whole website atmospherics on consumers' responses. Notwithstanding, Kim *et al*. (2007) address this issue, and investigate the effect of a single stimulus on consumers' perceptions and responses. The authors did not consider the impact of virtual theatrics or virtual layout and design in their online S-O-R model. Building upon Kim *et al*.'s (2007) empirical study, Sautter *et al*.'s (2004) and Manganari *et al*.'s (2009) theoretical models, this thesis investigates the effect of 3D product visualisation on a website atmospheric. This thesis felt that it is important to measure how consumers, within the online retail context, could imagine the 3D presented products. Particularly, we introduced our new construct, namely 3D authenticity, to reflect customers' virtual experience, where customers can feel the authenticity of the 3D products. The addition of this new notion to the Organism part (O) and the antecedents of 3D authenticity (the main parts in the stimulus part) distinguish this study from previous research that has studied the impact of a specific cue, such as music, graphic, photos, and product presentation, on a website atmospherics. This thesis expects that this addition will help marketers to understand customers' hedonic and utilitarian values within the organism part of the online S-O-R model. The conceptual framework (Figure 4.1) illustrates the main hypotheses that this study has used to test and evaluate the constructs relationships based on the online S-O-R framework.

4.8.1 The Stimulus Part (S), 3D Authenticity Antecedents (Control and Animated Colours)

To define the main antecedents of the 3D authenticity construct, current research argues that interactivity and vividness of a 3D flash are the main antecedents of the 3D authenticity. Particularly, users' ability to easily zoom in or out, rotate and view the 3D from different angles, and the 3D's ability to respond to a consumer's command relevantly and properly may enhance consumer's feelings of controlling the 3D flash (Coyle and Thorson, 2001; Kline, 2003). In defining interactivity, this thesis follows the narrowest definition of interactivity and considers the control construct to represent interactivity in a 3D online retail context. Ariely's (2000) definition of control refers to users' abilities to customise and choose website contents to achieve their goals. This study focuses more on consumers' ability to control and easily interact with the 3D virtual model. Therefore, we define control as "*users' abilities to customise and choose the contents of the virtual model (i.e., 3D product visualisation), rotate, and zoom in or out on the product in the virtual model and the ability of the virtual model (3D) to respond to participants' orders properly*". This thesis hypothesises:

> *H_{6a}: A high level of control of 3D product visualisation increases 3D authenticity.*

3D vividness usually facilitates consumers' virtual experience (Li *et al*., 2002). Vividness provides more sensory depth and sensory breadth, which ends in a high picture quality and clear vision of the promoted 3D images. Scholars (e.g., Fortin and Dholakia, 2005; Klein, 2003; Shih, 1998) have empirically tested the importance of advertising vividness (i.e., breadth and depth) in enhancing consumers' responses toward online retailers. Furthermore, 3D vividness often enhances virtual experience by providing more sensory depth and breadth (Li *et al*., 2002, 2003). Non-immersive VR interfaces within online retailers currently generate and transmit only two main stimuli: visual and auditory (Kim and Forsythe, 2008; Suh and Lee, 2005). Some 3D products need visual and auditory channels for facilitating consumer products' inspection; others manifestly need only visual aspects. Furthermore, Pimentel and Teixeira (1994, p. 146 as cited in Suh and Lee, 2005) assert that visual stimuli are the main sensory cues in producing virtual experiences. This thesis focuses on one aspect of vividness, namely breadth, while holding depth constant. Moreover, it also focuses on one aspect of vividness breadth, namely animated colours. Animated coloured pictorial images are used here to represent consumers' ability to see 3D products with different animated skins. High-quality online animations enhance perceived realism (e.g., Fortin and Dholakia, 2005; Klein, 2003; Shih, 1998). Therefore, this thesis hypothesises:

> *H_{6b}: A high level of 3D animated colours increases perceived 3D authenticity.*

Specifically, this study considers vividness of the visual imagery, such that consumers can see online products with different colours (skins) just as they would see them in person. Media richness may lead to more realism experience, according to research on online shopping (Klein, 2003; Schlosser, 2003). Moreover, consumers' ability to change the animated colours of the 3D product might help them sense control over the product. Therefore:

> *H_{6c}: A high level of 3D animated colours increases control.*

4.8.2 The Organism Part (O)

In the S-O-R framework, organism refers to the "*internal processes and structures intervening between stimuli external to the person and the final action, reaction or responses emitted. Notice that the intervening processes and structures consist of perceptual, psychological, feeling, and thinking activities*" (Bagozzi, 1986, p.46, as cited in Sherman, Mathur and Smith, 1997). According to the online S-O-R paradigm (Kim *et al*., 2007; Richard 2005), the Organism part (O) consists of affective and cognitive states which mediate the relationship between the Stimulus (S) and Responses (R). Moreover, most of the work on online environmental psychology has focused on Mehrabian and Russell's (1974) Pleasure, Arousal, and Dominance Scale to measure the affective state (e.g., Eroglu *et al*., 2003; Mummalaneni, 2005). However, Eroglu *et al*. (2003) find that Mehrabian and Russell's (1974) PAD did not manage to capture the range of organic reactions to shopping environments in the online context. This research proposes three variables for the Organism state (O): 3D authenticity, utilitarian and hedonic values. 3D authenticity reflects consumers' psychological states of perceiving virtual objects presented in 3D product visualisation as authentic or actual objects in a sensory way. Utilitarian values reflect the cognitive perception of 3D product visualisation ability to provide consumers with more information about the illustrated products (objects). Hedonic values reflect the affective perception of 3D product visualisation ability to enhance consumers' enjoyment and fun. Current research argues that consumer psychological feelings of 3D authenticity which results from surfing 3D product visualisations may enhance their perceptions toward both hedonic and utilitarian values.

Effects of 3D Authenticity on Utilitarian Value

Scholars (e.g., Fiore and Jin, 2003; Fiore *et al*., 2005a; Kim *et al*., 2007; Klein, 2003; Li *et al*., 2001, 2002, 2003; Suh and Chang 2006) explain the importance of using 3D product visualisations in enhancing consumers' understanding of product attributes, features and characteristics. 3D visualisation increases consumers' involvement and encourages them to seek more information about the products (Fiore *et al*., 2005a). Suh and Lee (2005) propose a positive relationship between higher levels of 3D product visualisation and the need to find more information about the products' characteristics and features. Suh and Chang's (2006) empirical research of the influence of 3D product visualisation and product knowledge reveals a positive relationship between 3D and perceived product knowledge. Using 3D product visualisation helps consumers to imagine how a product may look and it gives them more details about the products' characteristics (Fortin and Dholakia, 2005; Klein, 2003; Shih, 1998). Therefore, this thesis hypothesises:

> *H_{6d}: 3D authenticity in a retailer website will positively affect website use for utilitarian value.*

Effects of 3D Authenticity on Hedonic Value

Scholars (Fiore *et al*., 2005b; Kim and Forsythe, 2007; Lee *et al*., 2006; Schlosser, 2003) report the importance of 3D product visualisation for the enhancement of the experiential aspects of virtual shopping. The above researchers find that the ability of 3D product visualisation to produce hedonic values for shoppers is greater than its ability to produce utilitarian values. Fiore *et al*. (2005b) assert that image interactivity technology produces hedonic value, which is highly correlated with consumers' emotional pleasure and arousal variables. Fiore *et al*. (2005a) posit the importance of virtual models in boosting hedonic value (enjoyment). Fiore *et al*. (2005a) also report the importance of a high level of image interactivity technology in comparison to a low level of image interactivity technology (in the low level conditions, consumers could only enlarge the static picture of clothing) in producing more hedonic value. Many scholars in the communication field (e.g., Heeter, 1992; Lombard and Ditton, 1997; Song *et al*., 2007) report the importance of enjoyment as a consequence of using 3D. Consumers use 3D product visualisation to have more fun, enjoyment, and entertainment (Kim and Forsythe, 2007). Such sources of fun or enjoyment come from consumers' ability to rotate, and zoom in or out of the product (Fiore *et al*., 2005a), seeing different animated coloured pictorial images that may enhance their mental pleasure when using 3D sites. Therefore:

> *H_{6e}: 3D authenticity in a retailer website will positively affect website use for hedonic value.*

4.8.3 The Response Part (R)

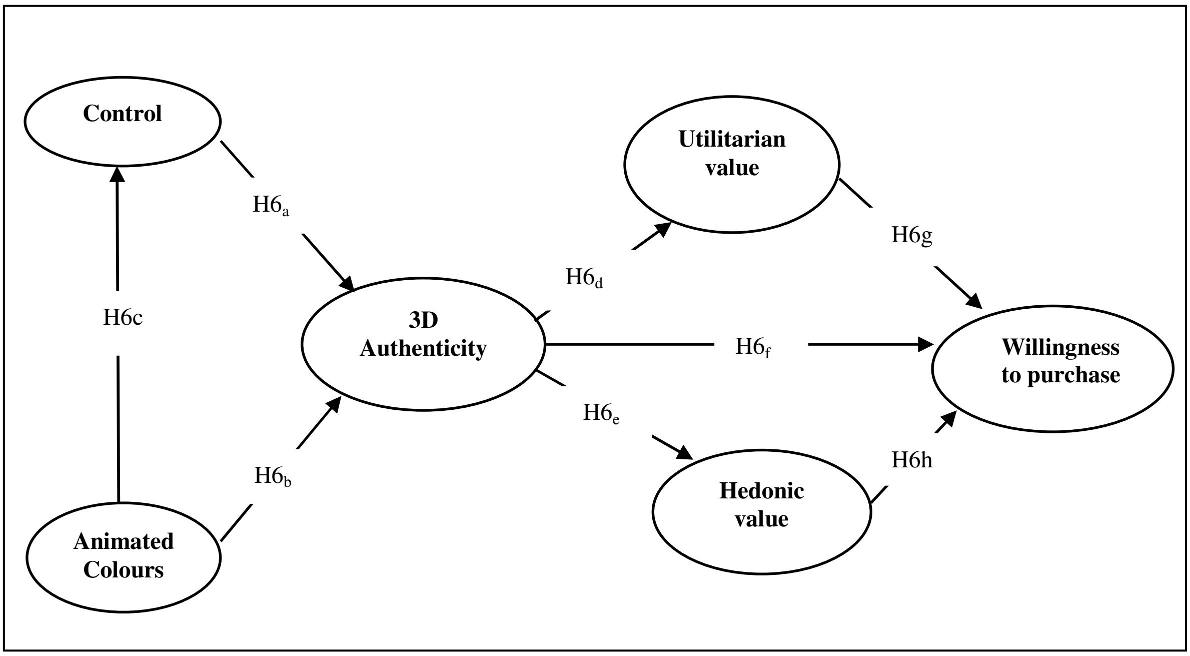
Effects of 3D Authenticity, Utilitarian and Hedonic value on Behavioural Intention

The role of 3D product visualisation in enhancing behavioural intentions appears well supported. 3D utilitarian and hedonic values improve willingness to purchase from an online retailer (Fiore *et al*., 2005a, 2005b), intention to buy (Schlosser, 2003), and purchase intentions (Li *et al*., 2001; 2003). Moreover, 3D realism improves users' beliefs and attitudes towards an online store (Klein, 2003). Therefore:

> *H_{6f}: The relationship between 3D authenticity and behavioural intention is positive.*
>
> *H_{6g}: The relationship between utilitarian value and behavioural intention is positive.*

H_{6h}: The relationship between hedonic value and behavioural intention is positive.

Figure 4.1 Conceptual Model: A proposed framework of 3D effects on online retailers using the online S-O-R model.



Source: Developed for this research (2009)

4.9 SUMMARY

This chapter illustrated the relevant literature to develop the proposed hypotheses and to underline the theoretical framework. This chapter also identified some gaps within the online S-O-R framework. On this base, this thesis developed a proposed theoretical framework to approach the research problems. Five research issues were developed and thirteen proposed hypotheses were proposed to guide data collection and analysis. See Table 4.1.

Table 4.1 Summary of research issues and hypothesis

Research Issues (Questions)	Research Hypotheses
Telepresence vs Authenticity: RQ1) How do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?	H_1: On the online retailer's website, 3D authenticity has a greater effect on users than does 3D telepresence.
3D and 2D experiences RQ2) How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailers'	 H_2: Compared to static pictures (2D) in a retailer website, 3D visualisation produces the different hedonic value

website? RQ3) How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailers' website?	for consumers. H_3: Compared to static pictures (2D) in a retailer website, 3D visualisation produces the same utilitarian value for consumers.
The effects of progressive levels of control and animated colours on 3D authenticity RQ4) How do different levels of 3D control and animated colours influence 3D authenticity?	 H_4: 3D authenticity will increase as levels of user control and animated colours in a retailer website increase.
The effects of progressive levels of hedonic and utilitarian values on behavioural intention: RQ5) How do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?	 H_5: Behavioural intention towards the online retailer will increase as levels of 3D hedonic and utilitarian values increase.
The online S-O-R framework: RQ6) How do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?	 H_{6a}: A high level of control of 3D product visualisation increases 3D authenticity. H_{6b}: A high level of 3D animated colours increases perceived 3D authenticity. H_{6c}: A high level of 3D animated colours increases control. H_{6d}: 3D authenticity in a retailer website will positively affect website use for utilitarian value. H_{6e}: 3D authenticity in a retailer website will positively affect website use for hedonic value. H_{6f}: The relationship between 3D authenticity and behavioural intention is positive. H_{6g}: The relationship between utilitarian value and behavioural intention is positive. H_{6h}: The relationship between hedonic value and behavioural intention is positive.

Source: Developed for this research (2009)

5 CHAPTER FIVE: METHODOLOGY CHAPTER

5.1 INTRODUCTION

The methodology chapter explains the main methodological foundations and the research design of the current thesis. To answer the research questions and to test the proposed hypotheses, this chapter is organised as follow. Section 5.2 presents the main reasoning for choosing the proposed methodology. Section 5.3 gives an overview of the main methods used for data collection. Section 5.4 explains the steps used to define and conceptualise the 3D authenticity construct. Section 5.5 explains the research instrument and scales used to answer this research questions and to test the proposed hypotheses. Section 5.6 describes the experimental methods used in each stage of this research. Section 5.7 presents the pilot study results. Section 5.8 explains the research sample and questionnaire design. Section 5.9 describes software packages and statistical techniques used in this research. Finally, Section 5.10 outlines the main ethical considerations related to this thesis.

5.2 JUSTIFICATIONS OF THE RESEARCH METHODOLOGY

Previous scholars (e.g. Burrell and Morgan, 1979; Deshpande, 1983) recognise the importance of identifying a marketing paradigm (a set of linked assumptions that aims to build a conceptual framework about a phenomenon that researchers are investigating, according to Deshpande, 1983) to provide researchers with guidelines which help them to understand the subject studied, to develop models and theories that can be used to solve certain problems, and to aid researchers to generalise validity and reliability of their research results.

Guba and Lincoln (1994, p. 107) classify research philosophies into three paradigms (or basic belief systems). First, epistemology relates to the relationship between the researcher and the research questions. Second, ontology relates to the nature of reality that a researcher is examining. Third, methodology relates to the questions and techniques used in any research to collect and validate empirical evidence. Furthermore, Deshpande (1983) classifies the main paradigms that marketers have used into two main schools of thought: positivism and idealism (phenomenology). Whereas the idealism paradigm is concerned with theory generation, and can often be achieved through the inductive theory building approach, the positivism paradigm is concerned with theory verification, and can often be achieved via the hypothetico-deductive approach (i.e., theory testing). To that end, Deshpande (1983) recommends marketers to focus on both paradigms (i.e. theory verification and theory generation) to avoid ‘method-bias’ that usually occurs as a result of focusing on one paradigm. Deshpande (1983) asserts the importance of using positivism and idealism paradigms. The author posits that theory generation often allows marketers to develop a series of propositions which can be tested later on by using theory verification (i.e., quantitative methods). Furthermore, the author points out that pursuing both paradigms has two effects. First, it enriches marketing meaning by identifying a new set of scales that may be useful in measuring marketing constructs. Second, it enhances research reliability, validity and generalisability.

The current research uses the two paradigms of positivism and idealism. First, this research starts with an idealism paradigm, focusing on a qualitative method (i.e., use of focus groups) to explore how using 3D product visualisation may provide participants with a sense of perceived authenticity, i.e., what elements make participants feel and think that using 3D product visualisation creates a simulation product experience that is very close to the experience they may have when visiting offline retailers? The main aim of doing the qualitative research in this study is an attempt to establish an appropriate scale to measure perceived 3D authenticity, which can be used later to test the proposed authenticity hypotheses. Second, the current study uses a positivist paradigm (i.e., a quantitative method) to test the proposed hypotheses and their causal relationships.

Although the quantitative (hypothetico-deductive) methodology was considerably adapted to carry out this research, the consideration of the qualitative (inductive) investigation methodology was required for the following reasons. First, this research has noticed the lack of appropriate existence scales to measure the authenticity construct of the 3D product visualisation within online retailers. Second, previous researchers have used the notions of telepresence or presence to measure consumers’ virtual experience. For example, previous researchers (e.g., Coyle and Thorson, 2002; Klein, 2003) have used Kim and

Biocca's (1997) scale to measure the virtual experience. Others (e.g., Li *et al*., 2002) have used the Television Commission-Sense of Presence Inventory Scale (TCPIS, developed by Lessiter, Freeman, Keogh and Davidoff, 2000). However, Kim and Biocca's (1997) scale and Lessiter *et al.*'s (2000) scale have been established to measure consumers' transportation into other places (i.e., being there). As a result of using the above scales, marketers end up with using scales that have been established and developed to measure immersive VR environments. This research believes that following these scales makes it difficult for e-retail researchers to apply a TV telepresence scale on a website retailer. For instance, in a computer-mediated environment, particularly when using 3D product visualisation, users can rotate the product, move it, roll it and zoom it in or out, something they would not be able to do when seeing an ad in televisions' set. Moreover, following Lessiter *et al.*'s. (2000) scale might make it very hard for marketers to focus on one aspect of the scale[2].

On the above basis, this thesis proposes that the 3D product visualisation experience, in an online retailer, should not be built on notions such as illusion, immersion and transportation. 3D product visualisation is not an illusion because consumers can find the illustrated 3D products (in a retailer's website) in offline stores (i.e., consumers are not escaping their real world). Furthermore, using the notion of illusion to describe the 3D product visualisation often creates a feeling that this world is undesirable (Lee, 2004). On the other hand, 3D product visualisation is not an immersion process, because consumers cannot use all their senses while navigating a 3D product visualisation in an online retailer's website. Even though the 3D in online sites can enrich visual and audio sensations, for the time being it does not provide tactile and smelling sensations (Kim and Forsythe, 2008). To that end, this thesis claims that 3D product visualisation is not a process of being mentally transported into other places because 3D product visualisation, as a non-immersive interface, would not temporarily eliminate users' surroundings and, in turn, users would not feel the departure or arrival to or from one place to another. Unlike the previous terminologies, the notion of authenticity is focusing more on products which consumers can find both online

[2] The scale consists of 44 items measuring four dimensions of telepresence: physical, engagement, naturalness, and negative effects.

and offline. This distinction makes the notions of immersion and telepresence not the proper terminologies to be used. Because (i) the immersion process (into a virtual reality environment) depends on technological hardware and software; (ii) immersion requires a simulation technology which often helps users to couple their sensory organs with the output devices of the computer to aid their virtual experience (Biocca and Delaney, 1995); and (iii) the notion of immersion reflects a process of being immersed into an illusion environment, such notion often reflects a negative meaning (Lee, 2004). On the other hand, the 3D flashes on a retail website would neither allow users to couple their sensory organs with the output devices of the computer, nor it allow them to use almost all their senses. Using immersion technology would help users to live a fictitious life that they wish to live in reality. However, the notion of the authenticity of the 3D flashes would help users to virtually experience a real (physical) product that they can interact with and use in real life. This thesis therefore asserts that a 3D virtual experience should be an authentic representation of the direct (offline) experience. The concept of 3D authenticity of the product visualisation implies the ability of 3D to simulate the product experience in bricks-and-clicks contexts.

Based on the existence scales, the current research has not found any of them helpful in tapping consumers' virtual experiences of examining 3D products on the online retailer. However, Fiore *et al.*'s (2005a) scale, was unclear as it used Shih's (1998) main dimensions of telepresence (i.e. interactivity and vividness) to develop a scale to measure image interactivity technology (i.e. clothing virtual models) telepresence. Even though the authors included interactivity and vividness as indicators of 3D telepresence, they did not explain which aspects of interactivity were focused on to measure telepresence. The following explain the main indicators that Fiore *et al.* (2005a, p. 45) used to measure telepresence: If I were actually shopping for clothing online, this website would "let me easily visualise what the actual garment is like", "give me as much sensory information about the product as I would experience in a store", "create a product experience similar to the one I'd have when shopping in a store", "allow me to interact with the product as I would in the store" and "provide accurate sensory information about the products". From the Fiore *et al.*'s (2005a) scale, it could be noticed that Fiore *et al.* (2005a) have used interactivity and vividness constructs as the main indicators of 3D telepresence. Notwithstanding, this research highlights the following unanswered questions in Fiore *el al*.'s (2005a) scale. What did the authors mean by interactivity? What aspects of interactivity have they focused on? This makes interactivity indicators unknown in Fiore *et al*.'s (2005a) study. This researcher believes that it is better to explain interactivity indicators in more detail. Heeter (2000, p. 75) describes interactivity as "*an overused and underdefined concept*".

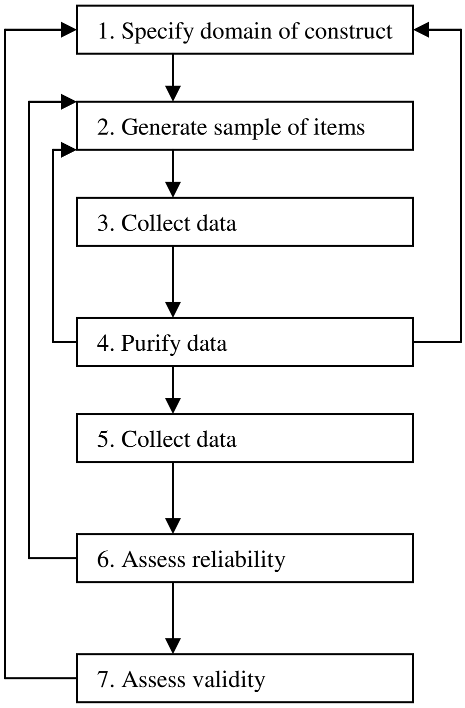
When choosing the above methodologies, the main research questions have been taken into considerations regarding the difference between 3D telepresence and 3D authenticity, 3D and 2D experiences, the effects of progressive levels of control and animated colours on 3D authenticity, the effects of progressive levels of hedonic and utilitarian values on behavioural intention and the online S-O-R Framework.

5.3 RESEARCH METHODS

This research uses mixed methods to collect the data. Mixed-method has proved its efficiency in social sciences (Creswell, 2003), such that it increases a construct reliability and validity (e.g. Creswell, 2003; Churchill, 1979). Morgan (1999) posits that combining qualitative and quantitative methods often enhance their strengths together in the same research scheme.

This thesis has used the following methods to collect the data: focus groups, experiments, questionnaire development, and a main survey as suggested by Churchill (1979). This study draws on previous scholarly literature to determine and define the domain of this research and its items of measurement for control, animated colours, 3D telepresence, 3D authenticity, hedonic values, utilitarian values, and behavioural intention. On the other hand, to measure 3D authenticity, this research follows Churchill's (1979) procedures to develop a scale of measurement for marketing constructs. A deep look at Churchill's (1979) proposed procedures reveals that the paradigm concentrates on qualitative and quantitative methods in developing better measures of marketing constructs. However, the nature of the current research paradigm is more quantitative than qualitative. Figure 5.1 shows the proposed steps in developing better measures of marketing construct.

Figure 5.1 Procedure for developing better measures.



1. Exploratory research:
Literature search
Focus group (experts in e-retailers and PhD students)

2. Questionnaire development:

Content validity
Pilot study
Cronbach's coefficient alpha

3. Experimental survey:

Factor analysis.

Cronbach's coefficient alpha.

Content validity
Construct validity

Source: Churchill, G. (1979)," A paradigm for developing better measures of marketing constructs"

5.4 THE 3D AUTHENTICITY CONSTRUCT

5.4.1 Specifying the Domain of the Construct

As no study, to the best of the author's knowledge, has so far produced a valid, reliable scale to measure the 3D authenticity, this thesis decided to fill the gap in this area. It has followed Churchill's (1979) procedures to develop a suitable scale. Churchill (1979) advises marketers, after a comprehensive review of the literature, to specify the domain of a construct. From the 3D literature, this thesis notices that the authenticity construct, derived from virtual experience contexts, has not been empirically examined in the context of e-retailers. Whereas the notion of 3D telepresence relates to a state of illusion or transportation (Lombard and Ditton, 1997), this thesis notices that telepresence is not the proper terminology that marketers should use since it represents a process of being mentally transported into other areas or being immersed into an illusion environment. Instead, this study explores the use of the 3D authenticity construct to simulate a real authentic product that a consumer can experience when engaging with an online retailer. To discover the main indicators for a 3D authenticity construct, this research captures all the previous literature review in the marketing field, and identifies the main indicators that previous academics have used. After identifying what to include (3D real product visualisation) and what to exclude (being there, immersion, and illusion terminologies) in a construct definition, Churchill (1979) suggests certain techniques to generate sample items to reflect a construct. For example, exploratory research, literature search, experience surveys, focus group, and insight-stimulating examples. This research follows two of the above techniques (to measure the 3D authenticity construct) that Churchill (1979) suggests, i.e., going back to the literature and carrying out focus groups. After reviewing the literature, this thesis employed four focus groups with experts in e-retailing to identify the main themes, concepts and items to tap the underlying construct.

5.4.2 Focus Group

This research starts with the focus groups to identify and operationalise the main elements that should be included in measuring the notion of the 3D authenticity construct. Four focus groups took place at Brunel University labs, in June 2008. To enhance group interaction discussion, each group consisted of at least five participants (Krueger, 1994; Morgan 1998) and lasted on average one hour. Participants (PhD students and online retailer lecturers) have surfed four websites: www.Sony.co.uk, www.Dell.co.uk, www.landsend.co.uk and www.ezface.com. After this, the focus groups start explaining how they feel and think about using 3D in online retailers. Moreover, the focus groups discussed whether the illustrated 3D products are real or not, and the main elements that make the 3D products look real. See Table 5.1. Focus group technique has been accredited in discovering people's feelings, thinking and perceptions (Churchill, 1979; Li *et al.*, 2001). For example, Li *et al.* (2001) employ protocol analysis to determine the main components of virtual experiences using 3D product visualisations. The authors assert that protocol analysis enhances their ability to understand how users feel and think toward the products when they navigate 3D product visualisations. The main goal of using the qualitative method may lead this research to discover new insights that have not been captured by the literature review and it may help this study to discover how 3D users are thinking and feeling toward the authenticity of a 3D product visualisation. See Appendix 8 for the transcripts.

Table 5.1 The details of focus groups and the core point discussed.

Date	Group size	Profile of participants	Session duration	Core points discussed
30/06/08	10	Age Range: 23-30 Gender: 5 male 5 female	50 minutes	- What is telepresence? - How do you feel/think of the 3D products? - What elements of the 3D makes you feel/think of this? - Does 3D give you a feeling of “being in a high street shop”? - What elements make you feel/think of being transported into a high street retailer? - Controlling questions - Responsiveness questions - Speed questions. - Being there questions. - Does 3D provide you with any enjoyment? - What elements make you feel this - Do you think that using 3D is helpful in gaining more information about products? - Do you think that using 3D may help in making your purchasing decisions? Does using 3D enhance your purchase intentions? Do your psychological feelings of being in a high retrial store facilitate your purchasing intentions? Do you think that using 3D may reduce your purchasing perceived risk?
1/07/08	4	Age Range: 27-32 Gender: 2 female 2 male	45 minutes	
2/07/08	6	Age Range: 25-31 Gender: 1 female 5 male	60 minutes	
01/08/08	5	Age Range: 30-45 Gender: 3 males 2 female	60 minutes	Comparison between the notions of telepresence and 3D authenticity.

5.4.3 Generate Sample of Items

The focus groups’ results analysed based on the 3D authenticity themes. Participants identified and discussed words that are related to 3D authenticity construct. Based on focus groups and the existing literature an initial pool of ten items was collected.

1. [X] I felt that I can touch it by hand.
2. [X] I felt that I am holding a laptop and moving it.
3. [X] I felt that I am dealing with a salesman.
4. [X] I felt that being able to zoom in or out, rotate the laptop and change its colours, let me visualise how a laptop looks like in an offline retailer.
5. [X] like the experience you would have when shopping in a store.
6. [X] In the laptop what you see is what you get.
7. [X] It gives me more information about how the product looks from inside, … and the colours.
8. [X] 3D authenticity lets me see the laptop as if it was a real one.
9. [X] This is much more visible for the colour; you can see the colour, you can see what ever.
10. [X] What you see in the 3D laptop is what you got on the high street.

5.5 RESEARCH INSTRUMENT, DEFINITION AND SCALES

This section explains the scales items used to measure the constructs of this study: control, animated colours, 3D authenticity, 3D telepresence, hedonic and utilitarian values, and behavioural intention. The 3D authenticity construct scale has been developed for the purposes of this research. The other scales have been developed from a review of the relevant literature. The current research instructs subjects that the study is looking at consumers' evaluation of an electrical retailer's website. This thesis assumes five point measures (1 to 5) frequently flanked by "strongly disagree" to "strongly agree". Table 5.9 summarises conceptual and operational definitions for each hypothesis.

5.5.1 Measuring 3D Authenticity

None of the previous definitions of telepresence that use 3D virtual models, however, can tap consumers' virtual experiences. A 3D virtual experience should be an authentic representation of the direct (offline) experience. Therefore, this research, based on previous scholarly literature which supports using certain terminology such as 'para-authentic' (Lee, 2004) and realism (Klein, 2003; Lombard and Ditton, 1997) constructs to describe the ability of 3D product visualisations to simulate real offline products, proposes a new notion that relates to the simulation of online products and virtual experience, namely the authenticity of the 3D product visualisation. Telepresence and presence are not particularly well suited to the online retail context because they reflect illusion and transportation to other places. In contrast, the concept of 3D authenticity of the product visualisation implies that ability to simulate the product experience in bricks-and-clicks contexts. This study proposes the following definition of perceived 3D authenticity in a computer-mediated environment: authenticity is a *psychological state in which virtual objects presented in 3D in a computer-mediated environment are perceived as actual (authentic) objects in a sensory way*. To measure 3D authenticity construct, Table 5.2 (based on the literature review and focus groups responses) illustrates the main indicators used to measure the 3D authenticity.

Table 5.2 Measuring 3D authenticity construct

Question before re-wording	Question after re-wording	Source(s)
Let me easily visualise what the actual garment is like.	3D creates a product experience similar to the one I would have when shopping in a store.	Fiore *et al.* (2005a)
	Being able to zoom in or out and rotate the laptop lets me visualise how the laptop might look in an offline retailer.	Researcher
	3D lets me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	Researcher
	3D lets me feel like I am dealing with a salesman how is responding to my orders.	Researcher
	3D lets me see the laptop as if it was a real one.	Researcher
	3D lets me feel that I can touch the laptop by hand.	Researcher
	3D lets me feel that I am holding a laptop and moving it.	Researcher

	3D enables me to see what I can get.	Researcher
	3D gives me more information about the product, how it looks from inside and its colours.	Researcher
	3D lets me see the colour as I see it in an offline retailer.	Researcher

5.5.2 Measuring Perceived Telepresence

To measure the 3D telepresence construct, this study uses Klein's (2003) scale based on Kim and Biocca's (1997) scale. More specifically, it uses four indicators from Kim and Biocca's (1997) scale based on Hopkins *et al.*'s (2004) recommendation. The 3D telepresence construct in this thesis refers to the sense of being there, i.e., being transported into other places. See Table 5.3.

Table 5.3 Measuring 3D telepresence construct

Question before re-wording	After re-wording	Source(s)
I forgot about my immediate surrounding when I was navigating through the exercise.	I forgot about my immediate surrounding when I was navigating through 3D sites.	Kim and Biocca (1997); Coyle and Thorson (2001)
While I was on the site, I sometimes forgot that I was in the middle of an experiment.	While I was on the 3D sites, I sometimes forgot that I was in the middle of an experiment.	Kim and Biocca (1997); Coyle and Thorson (2001)
While I was on the site, my body was in the room, but my mind was inside the world created by the company.	While I was on the 3D sites, my body was in the room, but my mind was inside the world created by the Brunel site.	Kim and Biocca (1997); Coyle and Thorson (2001)
While I was on this site, the world generated by the company was more real or present for me compared to the "real world".	While I was on this site, the world generated by Brunel (3D) was more real or present for me compared to the "real world".	Kim and Biocca (1997); Coyle and Thorson (2001)

5.5.3 Measuring 3D Control

This study measures interactivity by focusing on one dimension, namely the control construct. To measure the control construct of 3D product visualisations, this research uses Ariely's (2000) definition with some changes to suit the context of 3D product visualisation when consumers surf a retailer's' website with a 3D visualisation. Moreover, this research considers McMillan and Hwang's (2002), Liu's (2003), Song and Zinkhan's (2008) scales to measure the control construct (see Table 5.4). This thesis defines 3D control as *users' ability to customise and choose the contents of the virtual model (i.e., 3D product visualisation), users' ability to rotate, zoom in or out the product in the virtual model and the ability of the virtual model (3D) to respond to participants' orders properly.* The above definition concerns participants' ability to control the content and form of the 3D product visualisation (i.e., being able to zoom in or out and rotate the product) and to get relevant responses from the 3D product simulation. Notwithstanding, previous scholars such as Klein (2003) have focused only on the control construct when identifying interactivity, Klein's (2003) definition of the control construct was not related to 3D product simulations. Instead, it was related to controlling the form (text order) of an online advertisement.

Table 5.4 Measuring control construct

Question before re-wording	After re-wording	Source(s)
While I was on the website, I could choose freely what I wanted to see.	I felt that I had a lot of control over the content of the laptop's options (i.e., angles and information).	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)
While I was on the website, I could choose freely what I wanted to see.	I felt that I had the freedom to choose the sequences of the laptop appearance (i.e., colour, and angles).	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)
While surfing the website, I had absolutely no control over what I can do on the site.	I felt it was easy to rotate the 3D laptop the way I wanted.	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)
I feel that I have a great deal of control over my visiting experience at the site.	I felt I could control the 3D.	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)

I feel that I have a great deal of control over my visiting experience at the site.	I felt it was very easy to zoom in or out on the 3D laptop.	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)
I was able to obtain the information I want.	I felt that 3D laptops responded to my orders appropriately (e.g., when I click on the blue colour the laptop became blue. When I click on information I got it).	Liu (2003); McMillan and Hwang (2002); Song and Zinkhan (2008)

5.5.4 Measuring 3D Animated Colours

This thesis considers Steure's (1992, p.75) definition of vividness "*the representational richness of a mediated environment as defined by its formal features, that is, the way in which an environment presents information to the senses*", and it follows Fortin and Dholakia's (2005) definition of vividness, which focuses on the sensory breadth (i.e., visual and colours). To measure 3D vividness, this thesis focuses on one aspect of vividness, namely breadth, while holding depth constant. Moreover, this thesis focuses on one aspect of vividness breadth, namely animated colours. Animated coloured pictorial images are used in this thesis to represent consumers' ability to see 3D products with different animated skins. To measure the animated colours construct, this thesis uses a modified version of Peg *et al.*'s (2004) scale based on Steure's (1992), Kim and Biocca's (1997), Coyle and Thorson's (2001) and Fiore *et al.*'s (2005a) scales. See Table 5.5 for more details.

Table 5.5 Measuring animated colours construct

Question before re-wording	After re-wording	Source(s)
I think there are lots of sensorial materials on this website.	The 3D site enables me to choose and to see different colours of the same laptop.	Peg *et al*. (2004). Based on Steuer (1992); Kim and Biocca (1997); Coyle and Thorson (2001)
I think the sensorial materials of this website are quite vivid.	Multicolour in the 3D laptop lets me easily visualise what the actual laptop is like.	Peg *et al*. (2004). Based on Steuer (1992); Kim and Biocca (1997); Coyle and Thorson (2001)
Gives me as much sensory	I think there are lots of	Fiore *et al*. (2005a)

information about the product as I would experience in a store	colours on this website.	
Lets me easily visualise what the actual garment is like.	Colour brightness of 3D laptop lets me visualise how the real laptop might look.	Fiore *et al*. (2005a)
I think there are lots of sensorial materials on this website.	The laptop movement illustrated by 3D helps me to visualise how the real laptop might look	Peg *et al*. (2004). Based on Steuer (1992); Kim and Biocca (1997); Coyle and Thorson (2001)

5.5.5 Measuring 3D and 2D Hedonic Values

The current research follows Babin *et al*. (1994, p.646) and Holbrook and Hirschman's (1982) definition of hedonic values (i.e., when using 3D or 2D product visualisation) to reflect shopping potential entertainment and emotional worth. Moreover, to measure the hedonic values, this study uses a modified version of Babin *et al*.'s (1994) scale. The modified scale was used to assess the value derived from using 3D or 2D product visualisation (websites). See Table 5.6.

Table 5.6 Measuring hedonic construct

Question before re-wording	Question after re-wording	Source(s)
This shopping trip was truly a joy.	This shopping trip was truly a joy.	Babin *et al*. (1994)
This shopping trip truly felt like an escape.	This shopping trip truly felt like an escape.	Babin *et al*. (1994)
This shopping trip was truly enjoyable.	This shopping trip was truly enjoyable.	Babin *et al*. (1994)
I enjoyed This shopping trip for its own sake, not just for the items I may have purchase.	I enjoyed this shopping trip for its own sake, not just for the items I may have purchase.	Babin *et al*. (1994)
I enjoyed being immersed in existing new product.	I enjoyed being immersed in existing new product.	Babin *et al*. (1994)
I continue to shop, not because I had to, but because I want to.	I continue to shop, not because I had to, but because I want to.	Babin *et al*. (1994)
I had a good time because I was able to act on the 'spur-of-the-moment'.	I had a good time because I was able to act on the 'spur-of-the-moment'.	Babin *et al*. (1994)
During the trip, I felt the excitement of the hunt.	During the trip, I felt the excitement of the hunt.	Babin *et al*. (1994)

While shopping, I was able to forget my problems.	While shopping, I was able to forget my problems.	Babin *et al.* (1994)
While shopping, I felt a sense of adventure.	While shopping, I felt a sense of adventure.	Babin *et al.* (1994)
This shopping trip was a very nice time out.	This shopping trip was a very nice time out.	Babin *et al.* (1994)

5.5.6 Measuring 3D and 2D Utilitarian Values

To measure the utilitarian values, the current research follows Fiore *et al.*'s (2005a) scale, based on Babin *et al.*'s (1994) scale, to assess the utilitarian values. This research defines utilitarian values as the ability of the 3D or 2D product visualisation to reflect shopping with a work mentality. See Table 5.7.

Table 5.7 Measuring utilitarian construct

Question before re-wording	After re-wording	Source(s)
Help me make a better decision about the product.	Help me make a better decision about the product	Fiore *et al.* (2005a)
Help me buy the right product.	Help me buy the right product	Fiore *et al.* (2005a)
Aid me in evaluating the clothing items.	Aid me in evaluating the laptop items.	Fiore *et al.* (2005a)
Give me more information about the product.	Give me more information about the product.	Fiore *et al.* (2005a); Babian *et al.* (1994)
While shopping, I found just the item(s) I was looking for.	Help me in finding what I am looking for.	Babian *et al.* (1994)
I accomplished just what I wanted to do on this shopping trip.	Help me to accomplish what I want.	Babian *et al.* (1994)

5.5.7 Measuring Behavioural Intention

To measure the behavioural intention construct, the current research developed a modified version based on Fiore and Jin's (2003), Kim *et al.*'s (2007) and Lee *et al.*'s (2006) scales. See Table 5.8. This research defines behavioural intention as users' willingness to purchase from the 3D or 2D sites.

Table 5.8 Measuring behavioural intention construct

Question before re-wording	Question after re-wording	Source(s).
Assuming the product on the website suits your taste or needs, how willing would you be to purchase products from this online apparel store?	Assuming the product on the website suits your taste or needs, how willing would you be to purchase a laptop from this online store?	Fiore and Jin (2003)
After seeing the website, how likely is it that you would buy clothes from this online store?	After seeing the website, how likely is it that you would buy a laptop from this online store?	Fiore and Jin (2003); Fiore *et al*. (2005a)
I would be willing to purchase clothes through this online store.	I would be willing to buy a laptop through this online store.	Fiore and Jin (2003) Fiore *et al*. (2005a)
I intend to buy clothes from this online store.	I intend to buy a laptop from this online store.	Fiore and Jin (2003)
I would be willing to recommend this online retailer to my friends.	I would be willing to recommend this online retailer to my friends.	Lee *et al*. (2006)
In the future, I would very probably shop at this online retailer.	In the future, I would very probably shop at this online retailer.	Kim *et al*. (2007); Lee *et al*. (2006)
I would visit this online retailer again.	I would visit this online retailer again.	Lee *et al*. (2006)

Table 5.9 Construct definition and operational definition

Research hypotheses	Construct	Conceptual definition	Operational definition
3D telepresence *vs* 3D authenticity (Questionnaire 1)			
H_1: On the online retailer's website, 3D authenticity has a greater effect on users than does 3D telepresence.	3D authenticity 3D telepresence	A psychological state in which virtual objects presented in 3D in a computer-mediated environment are perceived as actual objects in a sensory way (the author). The illusion of "being there" in a mediated environment. Based on Biocca (1997); Coyle and Thorson (2001).	3D authenticity is measured by the extent of agreement with statements in a 5-point Likert scale about the authenticity of the 3D site. 3D telepresence is measured by the extent of agreement with statements in a 5-point Likert scale about the telepresence of the 3D site.
3D vs 2D virtual experiences (Questionnaire 1)			
H_2: Compared to static pictures (2D) in a retailer website, 3D visualisation produces different hedonic value for consumers.	3D Hedonic 2D Hedonic	Using 3D product visualisation to reflect shopping potential entertainment and emotional worth. Based on Babin *et al*. (1994, p.646) and Holbrook and Hirschman (1982). Using 2D product visualisation to reflect shopping potential entertainment and emotional worth. Based on Babin *et al*. (1994, p.646) and Holbrook and Hirschman (1982).	3D hedonic is measured by the extent of agreement with statements in a 5-point Likert scale about hedonic of the 3D site. 2D hedonic is measured by the extent of agreement with statements in a 5-point Likert scale about hedonic of the 2D site.
H_3: Compared to static pictures (2D) in a retailer website, 3D visualisation produces the same utilitarian value for consumers.	3D Utilitarian 2D Utilitarian	3D product visualisation ability to reflect shopping with a work mentality. Based on Babin *et al*. (1994, p.646) and Holbrook and Hirschman (1982). 2D product visualisation ability to reflect shopping with a work mentality. Based on Babin *et al*. (1994, p.646) and Holbrook and	3D utilitarian is measured by the extent of agreement with statements in a 5-point Likert scale about utilitarian of the 3D site. 2D utilitarian is measured by the extent of agreement with statements in a 5-point Likert scale about utilitarian of the 2D site.

		Hirschman (1982).	
The effects of the progressive levels of control and animated colours on 3D authenticity (Questionnaire 2)			
H_4: 3D authenticity will increase as levels of user control and animated colours in a retailer website increase.	3D authenticity	As defined above.	3D authenticity is measured by the extent of agreement with statements in a 5-point Likert scale about the authenticity of the 3D site.
The effects of the progressive levels of 3D hedonic and utilitarian values on behavioural intention (Questionnaire 2)			
H_5: Behavioural intention towards the online retailer will increase as levels of 3D hedonic and utilitarian values increase.	Behavioural intention	Users' willingness to purchase from the online retailer.	Behavioural intention is measured by the extent of agreement with statements in a 5-point Likert scale about behavioural intention towards the 3D site.
The online S-O-R framework (Questionnaire 1)			
H_{6a}: A high level of control of 3D product visualisation increases 3D authenticity.	Control 3D Authenticity	Users' ability to customise and choose the contents of the virtual model (i.e., 3D product visualisation), users' ability to rotate, zoom in or out the product in the virtual model and the ability of the virtual model (3D) to respond to participants' orders properly. Based on Ariely (2000). As defined above.	Control is measured by the extent of agreement with statements in a 5-point Likert scale about controllability of the 3D site. As defined above.
H_{6b}: A high level of 3D animated colours increases perceived authenticity.	3D animated colour 3D Authenticity	Users' ability to see the 3D products with different animated skins. As defined above.	Colours are measured by the extent of agreement with statements in a 5-point Likert scale about colourability of the 3D site. As defined above.

H_{6c}: A high level of 3D animated colours increases control.	3D animated colour Control	As defined above. As defined above.	As defined above. As defined above.
H_{6d}: 3D authenticity in a retailer website will positively affect website use for utilitarian value.	3D authenticity Utilitarian value	As defined above. As defined above.	As defined above. As defined above.
H_{6e}: 3D authenticity in a retailer website will positively affect website use for hedonic value.	3D authenticity Hedonic value	As defined above. As defined above.	As defined above. As defined above.
H_{6f}: The relationship between 3D authenticity and behavioural intention is positive.	3D authenticity Behavioural intention	As defined above. As defined above.	As defined above. Behavioural intention is measured by the extent of agreement with statements in a 5-point Likert scale about behavioural intention towards the 3D site.
H_{6g}: The relationship between utilitarian value and behavioural intention is positive.	Hedonic value Behavioural intention	As defined above. As defined above.	As defined above. As defined above.
H_{6h}: The relationship between hedonic value and behavioural intention is positive	Utilitarian value Behavioural intention	As defined above. As defined above.	As defined above. As defined above.

Resource: Developed for this research. (2009)

5.6 EXPERIMENTAL METHODS

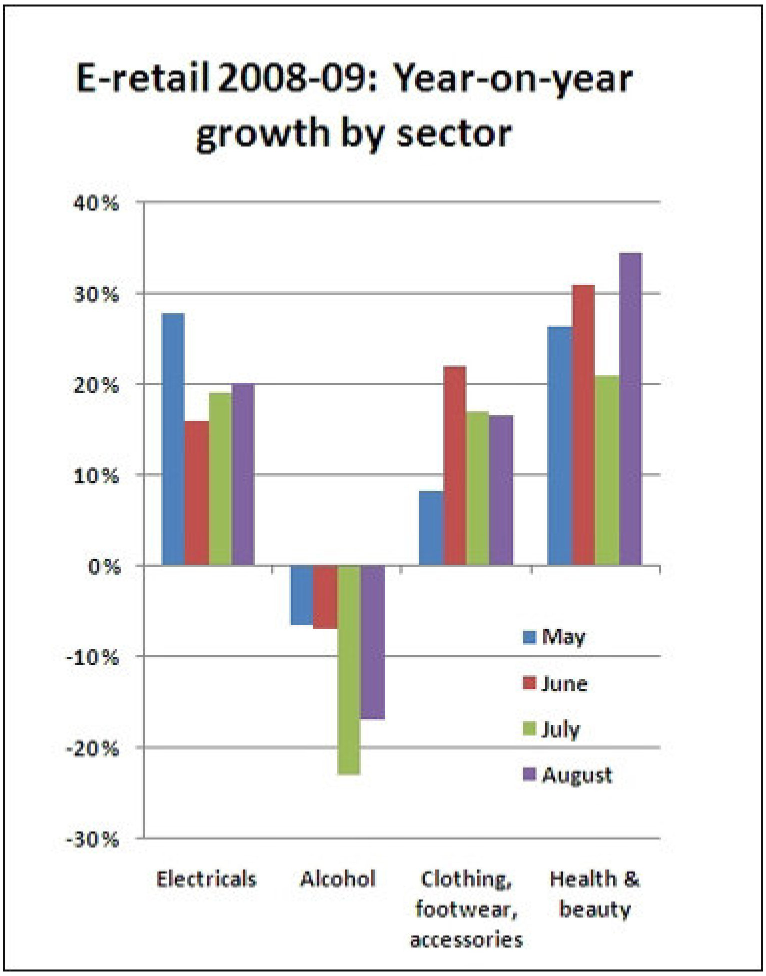
5.6.1 Experimental Interface Design, Procedure and Time

This research designs a hypothetical retailer's website with two stimuli. The first stimulus was illustrated on 3D product visualisation sites that allowed participants to view the focal product, laptops, from different angles; they also can rotate the products and zoom in or out. The 3D stimulus is intended to help consumers to imagine the product in appropriate and relevant ways and thus enhance their virtual experiences (Li *et al*., 2001). The second stimulus was illustrated on static sites where participants could only see product images of laptops without being able to change or modify them. Choosing two stimuli in one retailer's website came about to answer the research questions regarding the main influences of 3D product visualisations and 2D static pictures on consumers' perceptions (i.e., hedonic and utilitarian values).
In designing interfaces for this thesis, the research makes sure to include almost all the types of product visualisation forms that a consumer may find in any electrical online retailer. Moreover, this study adds more features and cases to the ones that might be found in real sites. For example, none of the national sites that sell laptops (e.g., Sony and Dell) has a flash combining both 3D visualisation and information about laptops.

This study chooses the electrical industry to investigate the impact of 3D and 2D product visualisations on consumers' virtual experience. Specifically, this study designs a fictitious website that sells one product, namely laptop computers. The choice of the laptop industry arises from the Image Marketing Retailer Group (IMRG, December, 2009) Capgemini e-Retail Sales Index, which shows that the number of U.K. online shoppers and online spending by U.K. consumers increase steadily. For example, in February 2008 online spending by U.K. consumers reached £4.2bn, which equates to £69 for every person in the U.K. and represents an increase of 46 per cent compared to February 2007. By December 2009 online spending has increased 11 per cent from 2008. Moreover, IMRG asserts that both electricals and clothing are the favourite purchases among U.K. shoppers, with 38 per cent and 32 per cent share of revenues respectively. See Figure 5.2 for latest information.

http://www.silicon.com/retailandleisure/0,3800011842,39170154,00.htm

Figure 5.2 Year-on-year growth across UK online retail sectors



Source: Image credit, silicon.com. (2008/2009)

To eliminate individual differences, this thesis employed a within-subjects design for the first four stages. Each subject, therefore, represents his or her own control (Greene and d'Oliveira, 1999). This design increases the statistical power of the experiment, because it requires fewer subjects than for a between-subjects design. Moreover, it helps reduce error variance, which is associated with individual differences. Furthermore, this design helps reduce costs because it takes several observations from the same subject (Greenwald, 1976; Keppel and Wickens, 2004). However, Bordens and Abbott (2008) posit that carrying out an experimental design using a within-subjects design is not disadvantage free. The authors emphasise carryover effects as one of the most vital disadvantage. To deal with the carryover problem, this research follows a counterbalance order strategy to make sure that all the sample candidates have surfed and used all stimuli (i.e. static pictures and 3D product visualisations) randomly. To do this**,** for example, 50% of the sample surfs the static pictures and then surfs 3D product visualisations. On the other hand, the remaining 50% surfs 3D product visualisations first and then surfs the static pictures in the designed websites.

As an aside, this thesis notes that most previous research in this field has been carried out using either a between-subjects design or a mixed design (e.g., Fiore and Jin, 2003; Fiore *et al*., 2005a; Kim *et al*, 2007; Li *et al*., 2002; Suh and Chang, 2006). As a result, the previous research has ended up with two separate samples in which some participants used 3D product visualisations and others used static pictures. Many authors, such as Grice (1966) and Bordens and Abbott (2008), assert the possibilities of having different functional relationships when using between-subjects designs. The authors posit that researcher's ability to compare results when employing a within-subjects design is greater than when employing a between-subjects design.

The designed websites (in all the stages) were not previously known to the users, nor did users have any knowledge of the fictitious brands on the sites. Thus, this thesis eliminated any impact of previous experiences or attitudes (Fiore *et al*., 2005a). The designed sites offer a wide variety of laptops, similar to those that many college-aged women and men currently buy and use. Therefore, the created sites provide a suitable context for the present sample.

This thesis follows Zajonc's (2001) recommendation regarding the time limit to a stimulus. Zajonc (2001) asserts that time exposure influences users' end responses. Moreover, some authors (e.g., Fiore and Jin, 2003; Fiore *et al*., 2005a; Kim *et al*., 2007) have followed Zajonc's (2001) study in determining the appropriate time exposure to an online stimulus (i.e., 3D) and they reported the importance of time exposure to any experiment that used 3D product visualisation. The current research follows the previous studies (e.g., Fiore and

Jim, 2003; Kim *et al*., 2007) in determining the limit exposure for each stimulus up to five minutes. After surfing, the stimuli subjects completed a questionnaire.

To test the hypotheses, this study designed five separate stages. In the first stage, this research tested H_1 by asking participants questions about the authenticity and telepresence of the simulation of the laptops. The second stage tested the hypotheses (H_2 and H_3) and demonstrated the difference between the indirect experience (i.e., using 2D static pictures) and the virtual experience (3D product visualisations) in providing more information and fun to consumers. Stage three tested H_4 and used a two-way repeated measures ANOVA to determine the effects of the progressive levels of the antecedents (control and animated colours) on 3D authenticity. The fourth stage tested H_5 and used a two-way repeated measures ANOVA to determine the effects of the progressive levels of 3D authenticity consequences (hedonic and utilitarian value) on the dependent variable (i.e., behavioural intention). Finally, in the fifth stage, this research developed a conceptual framework, based on the online S-O-R framework, and tested the relationships in the proposed model using the high levels of 3D authenticity antecedents, consequences, and behavioural intention. The impact of control and animated colours on 3D authenticity; and the impact of 3D authenticity, hedonic and utilitarian values on behavioural intention were tested.

5.6.2 Stage 1: 3D Authenticity Vs 3D Telepresence

Methods

Stimulus and Interface Design

The goal of Stage 1 was to determine the significance of 3D authenticity and telepresence in simulating the laptops to test H_1. This thesis designed a hypothetical retailer's website with one stimulus for this stage. The stimulus was illustrated on 3D product visualisation sites that allowed participants to view laptops as the focal product, from different angles; they also can rotate the products and zoom in or out on them, change the colour and get information about their features and attributes. Participants can see almost all the aspects they like to see in an offline retailer shop (Appendix 1). Based on Kim and Biocca's (1997) scale of telepresence and the developed scale of 3D authenticity, a comparison between the two constructs took a place.

5.6.3 Stage 2: 3D and 2D Experiences

Methods

Stimulus and Interface Design

In the second stage, this thesis tested how consumers perceived the utilitarian and hedonic values extracted from 3D sites in comparison to the 2D sites. This study designed two websites, using 2D static picture and 3D product visualisation forms, to test the comparison between 2D and 3D utilitarian and hedonic values (H_2 and H_3). The first site reflects a normal static (2D) website in which laptops are presented by images with multicolour and different positions of the laptops. Moreover, participants can see and read almost all the information they seek when searching the laptop in an offline retailer (e.g., speed, capacity, hard disc, and monitor). In a second site, the laptops are presented with 3D flashes which participants can zoom in or out, rotate and see the product with different colours and get information about the laptops features, attributes, functions and external appearances. See Appendices 2a and 2b.

Dependent Variable

This research considers utilitarian and hedonic constructs as the dependent variables (each stands alone). To measure 3D and 2D utilitarian values, this study adopted a modified version of Fiore and colleagues' (2005a) scale. To measure 3D and 2D hedonic values, this study adopted a modified version of Babin and colleagues' (1994) scale.

Pre-Test (Manipulation Checks)

A series of pre-tests was run to test several 3D flashes and 2D static sites based on their hedonic and utilitarian dimensions (5-point scales). Manipulation checks were used to determine whether the participants have noticed the differences between the various conditions of each construct. The first manipulation check aimed to test different levels of the 3D utilitarian value. Participants explored a

3D flash in which they could get information about the laptop (e.g., speed, capacity, hard disc, and monitor); and they also explored a 3D flash that gave the minimum information (i.e., only the external appearance). After each level they were shown the following question: To what extent do you consider that the 3D site is utilitarian? The second manipulation check aimed to test different levels of the 3D hedonic value. Participants explored 3D sites with animated coloured pictorial images intended to enhance their mental pleasure; and they also explored 3D sites in monochrome without the animated images. After each level they were shown the following question: To what extent do you consider that the 3D site is hedonic? Results are explained in the results chapter.

In a third manipulation check, this research aimed to test if participants have noticed the differences between the various levels of 2D hedonic and utilitarian constructs. Participants used a 5-point Likert scale to indicate their agreement or disagreement with the following items for each condition. For instance, participants explored a 2D static site from which they could get information about the laptop (e.g., speed, capacity, hard disc, and monitor) and they explored a 2D static site which could give them the minimum information about a laptop (i.e., only the external appearance with slight information) and then after each level they were shown the following question: To what extent do you consider that the 2D static site is utilitarian? On the other hand, participants explored a 2D site with a high level of hedonic value (multicoloured pictorial images and an ability to enlarge the front picture of a laptop) which is expected to enhance their mental pleasure. In turn, participants explore a 2D static site with a low level of hedonic value (only one laptop with one colour and inability to enlarge the front picture). After each level they were shown the following question: To what extent do you consider that the 2D static picture site is hedonic? Results are explained in the results chapter.

5.6.4 Stage 3: The Progressive Level of Control and Animated Colours Methods

Stimulus and Interface Design

The third stage serves two objectives. Firstly, it measures the various effects of the progressive levels of control and animated colour of 3D flashes on 3D authenticity. Secondly, it gives an indication about whether the high levels of control and animated colour will support hypothesis H_4 in this study. This thesis designed a hypothetical retailer website with one 3D stimulus that allows participants to view the focal product, laptops, from different angles; participants can rotate the laptop, zoom it in or out and they also can change the laptop colours.

Participants surfed four conditions in a 2 (control: high *vs*. low) × 2 (animated colours: high *vs*. low) within-subjects design. Figure 5.3 and Table 5.10 explain the different conditions designed for this stage. See Appendix 3 for more details. The first flash contained a laptop that participants could zoom in or out, rotate, and view with different colours. The second flash featured a laptop that participants cannot zoom in or out, but they can rotate and change the colour. In the third flash, they could still zoom and rotate, but not change the laptop colour (i.e., they can see the laptop with a single colour). Finally, in the fourth flash, participants could do nothing with the laptop, which simply rotated on its own (with a single colour). The main effect of each variable and their interactions analyses are explained in the data analysis chapter.

Dependent Variable

To measure the effects of the progressive levels of control and animated colours, this thesis used 3D authenticity as the dependent variable and measured it via our scale.

Pre-Test (Manipulation Checks)

This study ran a series of pre-tests to develop the stage materials. In the first pre-test, respondents were asked to rate several 3D flashes based on their controllability and colourability dimensions (5-point scales). Manipulation checks were used to decide if the participants have noticed the differences between the various conditions of each construct. For controllability, participants explored a 3D flash that they could control by zooming in and out and rotating;

and they also explored a 3D flash that zoomed in and out and rotated on its own, which they could not control. After each level, participants were shown the following question: To what extent do you consider that the 3D flash is controllable? For colourfulness, participants explored a 3D site on which they could see different colours of the same laptop and they also explored a 3D site on which they could see the laptop only in a single colour. After each level, they were shown the following question: To what extent do you consider that the 3D site is colourful? Results are explained in the results chapter.

Figure 5.3 Stage 3, the progressive levels of control and animated colours constructs

	High Control	Low Control
High Animated Colours	(1)	(2)
Low Animated Colours	(3)	(4)

Table 5.10 Explanation of different conditions in Stage 3

Cell No.	Condition	Explanation
1	High control and high animated colours.	Participants can zoom in or out the laptop, rotate it and see it with different colours.
2	Low control and high animated colours.	Participants cannot zoom in or out the laptop, but they can rotate it and see it with different colours.
3	High control and low animated colours.	Participants can zoom in or out the laptop, rotate it and see it with one colour.
4	Low control and low animated colours.	Participants cannot zoom in or out the laptop, but they can rotate it and see it with one colour.

5.6.5 Stage 4: The Progressive Levels of Hedonic and Utilitarian Levels Methods

Stimulus and Interface Design

The fourth stage serves two objectives. Firstly, it measures the various effects of the progressive levels of hedonic and utilitarian value of 3D flashes on behavioural intention. Secondly, it gives an indicator of whether the high levels of hedonic and utilitarian will support hypothesis H_5. This thesis designed a retailer's website with one stimulus for this stage. The stimulus was illustrated on 3D product visualisation sites that allowed participants to view the focal product, laptops. Participants surfed four conditions in a 2 (hedonic: high *vs.* low) × 2 (utilitarian: high *vs.* low) within-subjects design. Figure 5.4 and Table 5.11 explain the different conditions designed for this stage. See Appendix 4 for more details. The first flash contained a laptop that participants could see its attributes, functions, features and they could zoom in or out, rotate, and change the colour. The second flash featured a laptop that participants could see its attributes, functions, features, also they can rotate it and see it with one colour, but they cannot zoom in or out. In the third flash, participants can see the minimum features of a laptop (e.g., external appearance); they can zoom in or out on, rotate and see it with different colours. Finally, participants can see the minimum features of a laptop (e.g., external appearance) and they cannot zoom in or out, but they can rotate and see it with one colour. These 3D sites, and particularly the flash that contained information, distinguish the current research from previous studies that have reported the significant role of 3D in enhancing fun and enjoyment values more than utilitarian values (e.g., Fiore *et al.*, 2005b; Kim and Forsythe, 2007; Lee *et al.*, 2006; Schlosser, 2003). Moreover, unlike previous studies that focused on perceived product knowledge, this design enhances consumers' actual product knowledge. The main effect of each variable and their interactions analyses are explained in the data analysis chapter.

Dependent Variable

This research used the behavioural intention construct as the dependent variable, indicated by a modified version of Fiore's and colleagues' (2005a) scale.

Figure 5.4 Stage 4, The progressive levels of 3D hedonic and utilitarian values constructs

	High Hedonic	Low Hedonic
High (3D) Utilitarian	(1)	(2)
Low (3D) Utilitarian	(3)	(4)

Table 5.11 Explanation of different conditions in Stage 4

Cell No.	Condition	Explanation
1	High utilitarian, high hedonic.	Participants can see the laptop attributes, functions, features and they could zoom in or out on, rotate, and change the colour.
2	High utilitarian, low hedonic.	Participants can see the laptop attributes, functions, features, also they can rotate it and see it with one colour, but they cannot zoom in or out.
3	Low utilitarian, high hedonic	Participants can see the minimum features of a laptop (e.g., external appearance); they can zoom in or out on, rotate and see it with different colours.
4	Low utilitarian, low hedonic	Participants can see the minimum features of a laptop (e.g., external appearance) and they cannot zoom in or out, but they can rotate and see it with one colour.

Pre-Test (Manipulation Checks)

A series of pre-tests was ran to test several 3D flashes based on the hedonic and utilitarian dimensions (5-point scales). Manipulation checks were used to determine whether the participants have noticed the differences between the various conditions of each construct. For the utilitarian value, participants explored a 3D flash in which they could get information about the laptop (e.g., speed, capacity, hard disc, and monitor), and they also explored a 3D flash that gave the minimum information (i.e., only the external appearance). After each level they were shown the following question: To what extent do you consider that the 3D site is utilitarian?

For the hedonic value, participants explored a 3D site (with animated coloured pictorial images which they can zoom in or out and rotate) which intended to enhance their mental pleasure; and they also explored a 3D site in monochrome without the animated images or the ability to zoom in or out. After each level they were shown the following question: To what extent do you consider that the 3D site is hedonic? Results are explained in the results chapter.

5.6.6 Stage 5: The Online S-O-R Framework

Methods

Stimuli and Design

Using the online S-O-R framework and depending on the results of Stages 1, 2, 3 and 4, this research designed a retailer website which has a 3D flash with high levels of control, animated colours, utilitarian, and hedonic values to measure the effects of control and animated colours on 3D authenticity, the impact of 3D authenticity on utilitarian and hedonic values, and the influence of 3D authenticity, hedonic and utilitarian constructs on the behavioural intention construct. The main purpose of this stage was to test the goodness-of-fit indexes and the proposed hypotheses for the online S-O-R model. This thesis designed one stimulus, a 3D flash (site), for testing the proposed hypotheses. The site allows participants to control the content and form of the 3D flash. For example, participants can zoom in or out on the product, rotate it and can see different parts of the product when clicking on it. The 3D flash permits participants to change the colour of the laptop and see it with animated colours. Also the flash allows participants to get actual and perceived information (utilitarian) about the laptop features and attributes. Moreover, the designed site enhances participants' fun and enjoyment values by enabling them to control (i.e., to zoom in or out and rotate), to change the colour of the laptop and to see more information about the product. See Appendix 5 for more details. In designing this interface, this thesis considers a comprehensive site, to visualise an electrical online retailer, and adds more features and cases to the ones that might be found in real online retailers' sites to surpass an actual experience.

5.7 PILOT STUDY

5.7.1 Item Generation Results

Only the 3D authenticity construct and its scale have been developed by this research. The remaining scales have been modified based on well known scales that have high reliability and validity. Moreover, each construct is multi-item, as Churchill (1979) recommends. The questionnaire contains 5-point Likert-type scales, anchored by "strongly disagree" and "strongly agree". To measure the control construct, this thesis developed a five-item scale that centres on users' ability to rotate and zoom in or out and rotate the virtual model based on Liu's (2003); McMillan and Hwang's (2002); and Song and Zinkhan's (2008) scales. To measure vividness of the animated colours, this thesis developed a four-item scale based on Peg *et al*'s. (2004), Steure's (1992); Kim and Biocca's (1997); and Coyle and Thorson's (2001) studies. The items map how closely the simulated sensory information reflects the real product. For 3D telepresence, this thesis used a modified version of Kim and Biocca's (1997) scale with four items. This thesis could not find an existing scale to measure 3D authenticity so it developed a new ten-item scale (based on the literature and focus groups). To measure hedonic and utilitarian values Babin *et al.*'s (1994) scale and Fiore *et al.*'s (2005) scale, based on modifications of Babin *et al.*'s (1994) scale, were used. To measure behavioural intention, a modified version of Fiore and colleagues' (2005a) scale was used. In total, the first draft of the questionnaire comprised of 66 items. See Table 5.12.

Table 5.12 The constructs and the number of initial items

Construct	Number of initial items
3D Control	6 items
3D Animated colours	5 items
3D Telepresence	4 items
3D Authenticity	10 items
3D Hedonic values	11 items
3D Utilitarian values	6 items
3D Behavioural intention	7 items
2D Hedonic values	11 items
2D Utilitarian values	6 items

5.7.2 Purifying Measures

The third step in Churchill's (1979) paradigm is to purify the measurement scales via checking the reliability and validity for all scale items. McDaniel and Gates (2006, p. 224-227) define validity as "the degree to which what the researcher was trying to measure was actually measured". This thesis conducted two types of validity, during the preliminary stages and before conducting the main survey; faces validity and content validity. On the other hand, McDaniel and Gates (2006, p. 222) define reliability as "the degree to which measures are free from random error and, therefore, provide a consistent data". This thesis measured the reliability test by Cronbach's alpha which should be at least 0.70 or more (Hair *et al.*, 2006). Using validity and reliability measurements discussed above, the scales have been purified using the following two ways.

Qualitative Assessment

During the qualitative assessment, this study assessed two types of validity. First, face validity, "the degree to which a measurement seems to measure what it is supposed to measure" (McDaniel and Gates, 2006, p. 225). Secondly, content validity, "the responsiveness, or sampling adequacy, of the content of the measurement instrument" (McDaniel and Gates, 2006, p. 225) have been conducted for all constructs and especially for 3D authenticity construct by submitting the items to evaluations by academics (lecturers in online retailing and Ph.D. students). These respondents considered the items (questions) relevant and adequate for measuring the constructs.

Quantitative Assessment

In analysing the pilot study (n = 50), this thesis conducted Cronbach alpha reliability and factor analysis for each construct alone. The 3D authenticity construct, Cronbach's alpha, reveals a value of 0.873, which is above the recommended threshold (0.7, according to Hair *et al.*, 2006). Moreover, the result of item-to-total correlation coefficient alpha shows that only five items correlated above 0.30, and the other five items which failed to achieve the correlation standards of 0.30 were discarded. This study ran an exploratory factor analysis on the remaining five items (n = 50) to check if the 3D authenticity scale is supported by the data. The KMO statistic reveals 0.793, above the minimum recommended value of 0.60 (Kaiser, 1974) and the Barlett's test of sphericity yielded an χ^2 value of 93.752 ($p < 0.001$), suggesting an acceptable level of the common variance. Cronbach's alpha of the remaining five items was 0.843, which is above the recommended minimum threshold (0.7). The five retained items each commenced with "after surfing the 3D sites", and then obtained responses to the following: "3D creates a product experience similar to the one I would have when shopping in a store"; "3D lets me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)"; "3D lets me feel like I am dealing with a salesman who is responding to my orders"; "3D lets me see the laptop as if it was a real one"; and "Being able to zoom in/out and rotate the laptop let me visualise how the laptop might look in an offline retailer". The confirmatory factor analysis results are explained in the results chapter.

Table 5.13 shows the Kaiser-Mayer-Olkin (KMO) measurement of sampling adequacy and total variance explained. The KMO shows an acceptable level of adequacy (above .60 according to Hair *et al.*, 2006) for all constructs used in this study. Control and animated colours total variance explained were less than the recommended value (0.6 and above). However, all the items of control and animated colours constructs loaded above 0.5, so this study kept them for more analysis (Hair *et al.*, 2006). Hedonic values result revealed that this construct is a multi-dimensional construct (i.e., this construct has items that loaded into two factors). However, in theory, hedonic value is a unidimensional scale. Results in Table 5.14 show that after dropping the items that have communalities below 0.6 hedonic value construct loaded into one factor. The Bartlett Test of Sephericity was significant for all constructs, which indicating correlations presence among all constructs.

Table 5.13 Measurement of sampling adequacy and total variance

construct	No. of items	Cronbach alpha	Sample size	No. of factors	KMO	Variance explained
Control	6	.834	50	1	.834	56.101%
Animated colours	5	.766	50	1	.677	52.256%
3D Telepresence	4	.843	50	1	.826	62.111%
3D Authenticity	5	.843	50	1	.793	68.501%
3D Hedonic value	11	.917	50	2	.877	66.604%
3D Utilitarian value	6	.879	50	1	.816	63.268
Behavioural intention	7	.911	50	1	.864	66.001%
2D Hedonic values	11	.951	50	2	.897	77.942%
2D utilitarian values	6	.951	50	1	.876	80.937%

Table 5.14 Measurement of sampling adequacy and total variance

construct	No. of items	Cronbach alpha	Sample size	No. of factors	KMO	Variance explained
Control	6	.834	50	1	.834	56.101%
Animated colours	5	.766	50	1	.677	52.256%
3D Telepresence	4	.843	50	1	.826	62.111%
3D Authenticity	5	.843	50	1	.793	68.501%
3D Hedonic value	6	.879	50	1	.833	62.562%
3D Utilitarian value	6	.879	50	1	.816	63.268%
Behavioural intention	7	.911	50	1	.864	66.001%
2D Hedonic values	6	.937	50	1	.903	76.889%
2D utilitarian values	6	.951	50	1	.876	80.937%

5.8 TARGET POPULATION AND SAMPLING

Student samples have often been used in online shopping research (e.g., Balabanis and Reynolds, 2001; Kim *et al*., 2006; Li *et al*., 2002; 2003). This is justifiable as students are computer-literate, having few problems in using new technology. Students are potential consumers of electrical goods, having actual online experiences (Yoo and Donthu, 2001), being homogeneous in nature (Jahng, Jain and Ramamurthy, 2000; Calder *et al*., 1981), are topic relevant (Ferber, 1977) and their technological advances and innovativeness qualify them as a proper sample for online shopping research (Yoo and Donthu, 2001, p. 2).

5.8.1 Appropriate Number of Participants

The appropriate number of participants in a sample size is a tricky and complex decision. Hence, this study decided to explain the most commonly used techniques in determining the proper number of the sample size. First, rules of thumb; some scholars follow a rule of thumb in determining the proper sample size. For example, Roscoe (1975) suggests four rules of thumb to decide the proper sample size (n).

(i) The number of participants should be larger than 30 and the less than 500.

(ii) If researchers have more than one group (e.g., male or female), Roscoe (1975) recommends researchers to employ more than 30 participants for each group.

(iii) In the case of using multivariate analyses, Roscoe (1975) advises researchers to have a sample size that is larger, at least 10 times or more, than the number of variables used in the analysis. Furthermore, other scholars such as Stevens (1996) suggest having 15 cases per construct to calculate the proper sample size. Stevens (1996) posit that 15 cases per construct are sufficient to get trustworthy results from the multivariate analysis. In turn, Bentler and Chou (1987) advise researchers to determine the sample size based on number of parameters. For example, Bentler and Chou (1987) posit that if the data is normally distributed, then at least 5 cases per parameter is sufficient.

(iv) If the researcher is conducting a simple laboratory experiment where some conditions are controlled, then the appropriate sample size should be between 10-20 participants (Roscoe, 1975). Other scholars such as Krejcie and Morgan (1970) propos a table to determine the proper number of a sample size (S) derived from a population (N).

The second technique that scholars use in determining the adequate number of a sample size depends on the data analysis processes or techniques (Hair *et al.*, 2006). This study explains the five considerations that Hair *et al.* (2006) recommend to determine the proper sample size when using Structural Equation Modelling (SEM) techniques. First, according to Hair *et al.* (2006), if the distribution of the data deviates from the assumption of multivariate normality, then 15 respondents for each parameter is an acceptable number to minimise the problem of deviation from normality. Second, the sample size should range from 150 to 400 respondents, if the estimation technique is to be used. In other words, SEM is based on the maximum likelihood estimation (MLE) method, which gives adequate results if the sample size ranged from 150 to 400 respondents. Hair and colleagues (2006) explain that if the sample size exceeds 400, then the MLE method becomes more sensitive and results of the goodness-of-fit measures become poorer. Third, model complexity; this consideration relates to the number of constructs used in the analysis. In other words, the more constructs a model has, the more parameters should be used in the analysis and as a result the more sample size is needed to conduct the analysis. Moreover, Hair *et al*. (2006) assert that if a researcher is using a multi-group analysis, then, an adequate sample for each group is required. Fourth, missing data, Hair *et al*. (2006) posit that the more missing data research has, the greater sample size a study needs. Fifth, Hair *et al*. (2006, p. 741) advise researchers to consider communalities (average error of variance of indicators, and represent the average amount of variation among the measured/indicator variables explained by the measurement model) before deciding the proper sample size. Communalities should be above .5 (equals .7 standardised loading estimates); otherwise the study requires more sample size. For instance, Hair *et al*. (2006) assert that if any communality is between .45-.55, or the model has constructs with fewer than three items, then the sample size should be above 200. On the other hand, if the communalities are lower than .45 then the minimum sample size should be 300 or more.

Based on the above discussion and since this research is based on using ANOVA and SEM, this study decides to have a sample size of 300 plus in all the one-way repeated measure ANOVA (Stages 1 and 2) and the fifth stage to achieve trustworthy results. For the two-way repeated measures ANOVA (Stages 3 and 4) this study follows one of the rules of thumb that Roscoe (1975) suggests (for conducting an experiment) from 10 to 20 participants.

5.8.2 Sampling Techniques

This research employs a non-random sampling technique, namely, a convenience sampling technique (based on employing participants who are easily accessible, according to McDaniel and Gates, 2006). Bryman and Bell (2007, p. 198) posit that “in the field of business and management, convenience samples are very common and indeed are more prominent than are samples based on probability sampling". This technique has been chosen since this study has asked the permission of the participants before doing the experiments. Once the participants agree to do the experiments the study precedes, otherwise the study stops and seeks other participants.

5.8.3 Questionnaire Design

Three forms of questionnaires were developed for this thesis. The first was used for testing the study experimental manipulation checks (pre-tests). The second tested the progressive levels of the various constructs using perceived 3D authenticity and behavioural intention as the dependent variables (Stages 3 and 4, see Appendix 7). The third questionnaire was the main questionnaire, used as the main tool for collecting data to test the difference between 3D telepresence and 3D authenticity (Stage 1), the difference between 2D and 3D virtual experience (Stage 2), and to test the online S-O-R framework (Stage 5). The third questionnaire consisted of three parts (see Appendix 6):

Part one:
Asked the participants about their ability to control the 3D product visualisation, 3D animated colours, 3D authenticity, 3D telepresence, 3D hedonic and utilitarian values, and 3D behavioural intention.

Part two:

Asked the participants about 2D hedonic and utilitarian values.

Part three:

Contained twelve questions, asking participants about their use of the internet for e-shopping, number of times that they have bought a laptop online, number of years experience of using the internet, frequency of using the internet for surfing e-retailers, gender, marital status, age, level of education, annual income, the country that best describes participants culture and the school they belong to.

5.8.4 Justification for Using Five-Point Likert Scale

This study chooses a 5-point Likert scale with a mid point of neutral to collect the data. A 5-point Likert scale is commonly used and relatively easy to collect the data from respondents using a survey (Preston and Colman, 2000; Sekaran 2000). Notwithstanding, the decision to choose the Likert scale points is a matter of debate (Cox, 1986). For example, some authors prefer using scales of seven, nine and sometimes eleven points respectively, over scales of two, three or four points. The former increase reliability and validity of the research area and the latter generate lower internal consistency, validity and discriminating power (Preston and Colman, 2000). In turn, Hartely and Mclean (2006) find that using a scale of five points often increases response rates of any study up to 90 per cent. Moreover, Dawes' (2002) empirical research reveals that the reliability and validity slightly changed when using a seven-point Likert scale in comparison to using a 5-point Likert scale. Dawes (2002) posits that increasing reliability and validity of the Likert scale was not noticeable when she increased the responses from scales of seven to nine, or even from seven to ten. Dawes (2002) asserts that an eleven-point Likert scale generated the same mean as a 5-point Likert scale. Moreover, kurtosis and skewness of eleven-point and 5-point Likert scales showed some unsystematic differences. Neumann (1983) posits that using a 5-point and a seven-point Likert scale gives similar results (i.e., in regard to means and correlation coefficients). Moreover, the author recommends researchers to use a 5-point Likert scale instead of using a seven-point scale, especially when attitudinal research is being carried out.

5.9 DATA ANALYSIS TECHNIQUES AND STATISTICAL PACKAGES

This thesis consists of five laboratory stages. The first stage used a one-way repeated measure ANOVA to determine whether participants perceived the laptops demonstrated in 3D sites simulate a state of telepresence (being there) or an authentic product. In the second stage, a series of one-way repeated measure ANOVA was used to compare how participants perceived 3D utilitarian value in comparison with 2D utilitarian value, and to compare how participants perceived

3D hedonic value in comparison to 2D hedonic values. The third and fourth stages tested the effects of the progressive levels of the independent variables and their effects on the dependent variable. When analysing Stages 3 and 4, this study used two-way repeated measures ANOVA to determine the effect of each of the main constructs and their interactions. Finally, this thesis conducted a SEM using Analysis of Moment Structure (AMOS) 16.0 to determine the goodness-of-fit of indexes of the proposed model and to test the proposed hypotheses in the online S-O-R framework. Statistical Package for Social Sciences (SPSS), version 15.1, was used to analyse the primary data, and the repeated measures ANOVA tests. Moreover, the SEM was used to test the measurement model and the structural model. The following section justifies using SPSS and AMOS.

5.9.1 Preliminary Data Analysis

The adequacy of using SPSS has been accredited by many scholars (Field, 2005; Tabachnick and Fidell, 2007). SPSS has been used in this study for a number of purposes. First, coding, editing and checking missing data. Second, checking the assumptions of normality, linearity, multicolinarity, and outliers. In doing so, this thesis used the following tests; skewness-kurtosis, bivariate correlation matrix at 0.01 significant level (2-tailed), a Scatter/Dot matrix, box and whisker and normal probability plot, and univariate and multivariate outliers. Third, testing the manipulation checks and the progressive levels of the two-way repeated measures ANOVA. Moreover, this research conducted a series of one-way repeated measure ANOVA to test the scores on comparing 3D authenticity with 3D telepresence, comparing 3D hedonic with 2D hedonic values, and comparing 3D utilitarian with 2D utilitarian values. Fourth, analysing frequencies, mean and standard deviations for this thesis constructs. See the next chapter for more details.

5.9.2 Structural Equation Modelling (SEM)

The SEM has been used to test the proposed hypotheses in the online S-O-R framework. According to Tabachnick and Fidell (2007, p. 676), SEM is a "collection of statistical techniques that allow a set of relationships between one or more independent variables, either continuous or discrete, and one or more dependent variables, either continuous or discrete, to be examined". Using the SEM over SPSS came about after the following reasons (based on Hair *et al.*, 2006; Tabachnick and Fidell, 2007). First, the simultaneous ability of the SEM to test several dependent relationships between observable indicators and the latent variable (i.e., by using the measurement model), and to test the relationships among latent variables (i.e., by using the structural model) by calculating multiple regression equations are greater than other statistical packages (i.e., SPSS) which examine only one single relationship in a time. Second, the ability of the SEM to calculate unidimensionality, reliability and validity of each construct individually. Third, the ability of the SEM to test the confirmatory factor analysis, rather than exploratory factor analysis, gives it a plus advantage. Fourth, the ability of the SEM to estimate direct, indirect and total effects gives SEM more privileges over other statistical packages. Fifth, unlike other multiple variance techniques, SEM calculates measurement error and error variance parameters, and it provides the overall goodness-of-fit of the tested models.

Stages in Structural Equation Modelling

This research followed three stages to analyse the SEM data. First, this thesis started by analysing the measurement model (i.e., calculating confirmatory factor analysis) for each construct. This has been done for the following reasons:

(i) To make sure that the relationships between each unobserved construct and its observed items achieved the unidimensionality assumption. Confirmatory factor analysis (CFA) was used during this stage to ensure that the standardised factor loadings values are greater than .60 (.60 and above indicates a strong association between the items and their construct).

(ii) To calculate the validity and reliability of each construct. Even though this study carried out an exploratory factor analysis (EFA), Hair *et al*. (2006) considered CFA more powerful than EFA.

Second, a structural model is used to test the hypothesised or casual relationships between the latent constructs. Critical ratio values (i.e., t-values) are used to determine the significance or insignificance of the relationships between the unobserved (latent) constructs.

Third, invariance analyses have been used to determine the effects of gender, e-shopping experience, age, education levels and study backgrounds on the constructs and their relationships in the proposed research model. In doing so, this study followed three steps to conduct the invariance analyses. First, this thesis started by conducting a measurement invariance analysis (measurement weight) for each group (or sub group). If the result is invariant, then the data of each group is suitable for further analysis (i.e., structural invariance analysis). However, if the two groups understood the items in different ways (i.e., non-invariance), then this thesis identified the source of the non-invariance. To do so, this thesis identified the observed item(s) that caused the non-invariance and tried to fix it. After running the analysis again, if the result of the measurement model is invariance, then this thesis goes to the next step. However, if the results still non-invariant, then, this thesis stops the analysis. Second, after having the insignificant results in the measurement model, this thesis conducted the invariance structural model analysis to determine if gender, e-shopping experience, age, education levels, and study background groups have invariance or non-invariance results in perceiving the relationships between the unobserved constructs. In conducting this analysis, this study followed two steps:

(i) If the members of any group (e.g., the males and females groups) perceived the relationships between the constructs similarly (i.e., invariance), then, this thesis moved to the third step (i.e., latent mean invariance analysis).

(ii) However, if the members of any group perceive the relationships between the constructs differently (i.e., non-invariance), then this study determined the source of the non-invariance. Moreover, non-invariance results are calculated using the un-standardised direct, indirect and total effects.

Third, this thesis conducted the latent mean invariance analyses among latent constructs to determine if the groups have perceived each construct similarly (invariance) or differently (non-invariance). In all the three previous steps, this thesis reported $\Delta\chi^2$ and Δdf and fit indices (e.g., TLI, CFI and RAMSE) models for the comparison purposes.

Evaluating the Fit of the Model

Goodness of fit criteria and unidimensionality were used to evaluate the measurement model and its specification. On the one hand, unidimensionality was assessed by reliability tests (i.e., composite and Cronbach alpha reliabilities) and factor loadings for each construct alone. On the other hand, a variety of goodness-of-fit criteria have been chosen in this research since it is hard to depend on a single fit index to identify the correct model (Byrne, 2001). This thesis focused on three types of goodness-of-fit: absolute fit indices, incremental fit indices and parsimony fit indices.

First, absolute fit indices, according to Hair *et al*. (2006. p, 706-708), are used "to measure the overall goodness-of-fit for both the structural and measurement models collectively". Moreover, absolute fit indices "indicate the degree to which the hypothesised model reproduces the sample data" (Shah and Goldstein, 2006, p. 159). Absolute fit indices evaluate the goodness-of-fit of a certain model independently from any other model. This thesis has used the following absolute fit indices:

(i) The chi-square (χ^2) test which is related to "the fit between the sample covariance matrix and the estimated population covariance matrix" (Tabachnick and Fidell, 2007, p. 715). The discrepancy between the two matrices should not be statistically different ($p > .05$). However, using this fit only to assess the overall goodness-of-fit of the model has been criticised since chi-square is very sensitive to the sample size (Hair *et al*., 2006; Tabachnick and Fidell, 2007). Therefore, to quantify the degree of fit, many researchers do not reject or accept a model based only on the χ^2 value, but they take it in combination with other indices.

(ii) Goodness-of-Fit Index (GFI) which measures the relative amount of variance and covariance in the sample matrix that is jointly explained by population matrix (Byrne, 2001, p.82). GFI values range from 0 to 1 with values equal to or greater than .9 considered as good fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007).

(iii) Adjusted Goodness-of-Fit Index (AGFI) is used alongside GFI in this thesis. The main difference between GFI and AGFI is that the latter adjusts for the number of degrees of freedom in the specified model (Byrne, 2001, p. 82). AGFI values ranged from 0 to 1 with values equal to or greater than .9 considered as good fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007).

(iv) Byrne, (2001) and Hair *et al.* (2006) recommended researchers to consider the Root Mean Square Error of Approximation (RMSEA), which "takes into account the error of approximation in the population and asks the question: how well would the model, with unknown but optimally chosen parameter values, fit the population covariance matrix if it were available?" (Browne & Cudeck, 1993, pp. 137-138, as cited in Byrne, 2001, p. 84.) RMSEA represents how well a model fits a population (Hair *et al.*, 2006, p. 748). Moreover, RMSEA expresses fit per degree of freedom and it is sensitive to the number of parameters (MacCallum, Browne, Sugawara, 1996). RMSEA with values less than .05 indicates good fit, with values from .05 to .08 acceptable, and with values more than .08 considered as poor and unacceptable fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007).

Second, incremental fit indices are used for "assessing how well a specified model fits relative to some alternative baseline model" (Hair *et al.*, 2006, p. 749). Since absolute fit indices do not compare the models to a specific null model[3] (i.e. unlike incremental fit indices), this research used incremental fit indices

[3] Hair *et al.* (2006) referred to the baseline model as a null model

besides absolute fit indices. Particularly, this thesis focused on the following incremental fit indices: Normed Fit Index (NFI) which compares nested models. In other words, NFI compares the χ^2 value of the model to the χ^2 value of the independence model (Tabachnick and Fidell, 2007, p. 716). NFI values ranged from 0 to 1, with values equal to or greater than .9 considered as good fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007).

Since NFI index does not control for degrees of freedom and it underestimates fit in small samples (Byrne, 2001), Comparative Fit Index (CFI) is considered as an improved version of NFI index. CFI values ranged from 0 to 1, with values equal to or greater than .9 considered as good fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007). Finally, the Tucker-Lewis Index (TLI), also known as Nonnormed Fit Index (NNFI), which compares the χ^2 value of the model to that of the independence model and takes degrees of freedom for both models into considerations (Bentler, 1990) has been taken into account within this research. TLI index values ranged from 0 to 1, with values equal to or greater than .9 considered as good fit (Byrne, 2001; Hair *et al.*, 2006; Tabachnick and Fidell, 2007).

Third, when ever it is necessary, this thesis, used parsimony fit indices[4], particularly normed chi-square χ^2/df, to decide which model among the competing models is the best (Hair *et al.*, 2006). χ^2/df ratios on the order 3:1 or less are acceptable (Hair *et al.*, 2006, p. 748). Goodness-of-fit criteria are summarised in Table 5.15 below.

[4] Parsimony fit indices consider the model fit relatively to its complexity (Hair *et al.*, 2006, p. 749).

Table 5.15 Goodness-of-fit criteria used in this research

Fit indices	Abbreviation	Type	Acceptance level in this research
Coefficient alpha	α	Unidimensionality	$\alpha > 0.7$ adequate and > 0.5 is acceptable
Standardised regression weight	β		Beta > 0.15
Chi square (with associated degrees of freedom and probability of significant different)	χ^2 (df, p)	Model fit	$P > 0.05$ (at α equals to 0.05 level)
Normed Chi-square	χ^2/df	*Absolute fit and model parsimony*	$1.0<\chi^2/df<3.0$
Normalised Fit Index	NFI	*Incremental fit* Compare your model to baseline independence model	Values above 0.08 and close 0.90 indicate acceptable fit
Comparative Fit Index	CFI		
Goodness of Fit Index	GFI	Absolute fit	**≥ 0.90**
Adjusted Goodness of Fit Index	AGFI		**≥ 0.90**
Root Mean Square Error of Approximation	RMSEA		**< 0.08**

Source: Developed from Hair *et al*. (2005)

5.10 ETHICS CONSIDERATIONS

This study followed Brunel Business School ethics form. A number of considerations have been adopted before conducting the data collection. Within the research consent form, the researcher told all participants that their participation in this research is voluntary and that they can withdraw from the experiments at any time if they feel it is necessary. Moreover, participants have been told that they are free to decline to answer any question. Finally, confidentiality of participants' identities and confirmation of their data security (i.e., their data will not be passed to a third party) have been assured by the researcher. In the focus groups, all the sessions were tape recorded unless one of the participants disagreed. Based on the above, Brunel Business School granted approval to conduct this research.

5.11 SUMMARY

This chapter justified using qualitative and quantitative analyses to answer the research questions and to test the proposed hypotheses. Measurement scales for each construct has been identified, based on a well known previously tested scales. The 3D authenticity measurement scale has been developed for the purpose of this research based on Churchill's (1979) paradigm. Five stages have been developed for the purposes of collecting the data. In all the five stages, this research proposed a hypothetical website retailer which sells laptops using both 3D and 2D product visualisation forms. Sampling technique, experiments time and questionnaire design have been discussed. Finally, statistical techniques and ethical considerations have been presented.

6 CHAPTER SIX: DATA ANALYSIS

6.1 INTRODUCTION

In the previous chapter, the methodology of collecting the data was described. Chapter Six illustrates the process of collecting, preparing and analysing the data to test the research questions and the proposed hypotheses. Section 6.2 presents the steps of preparing, editing, coding and screening the data. Section 6.3 describes normality, linearity, multicollinearity and outliers of the 3D and 2D sites data. Section 6.4 explains exploratory factor analysis using the maximum likelihood factorising method and direct oblimn rotation method for the 3D sites. Section 6.5 presents the first stage results; a one-way repeated measure ANOVA used to test how participants perceived the 3D telepresence construct in comparison to the 3D authenticity construct. Section 6.6 explains the second stage results; a series of one-way repeated measure ANOVAs used to compare scores on the hedonic and utilitarian values when using 3D and 2D (static) sites. Section 6.7 discusses the third stage results; a two-way repeated measures ANOVA used to test the progressive levels impact of control and animated colours on the 3D authenticity construct. Section 6.8 discusses another two-way repeated measures ANOVA to test the progressive levels impact of 3D hedonic and utilitarian values on the behavioural intention. Section 6.9 demonstrates the fifth stage results; the structural equation modelling (SEM), in which measurement and structural models are tested and empirically reported. Finally, Section 6.10 demonstrates the invariance analyses results between gender, e-shopping experience, age, educational levels, and the study backgrounds.

6.2 DATA PREPARATION

6.2.1 Data Coding and Editing

To ensure completeness and consistency of the data, after collecting the data from the laboratories, data editing took a place (Tabachnick and Fidell, 2007), this research includes only respondents who finished doing all the experimental stages, since this research is based on laboratory sites, and once the participant has been discarded from the experiments it is hard to know what the respondent's answer might have been to the rest of the experiments. Missing data has been considered to be missing values. In the coding process, this research assigns a number to each question answered in an SPSS file. After data coding, this thesis conducts data editing to make sure that the coding process was done properly. Furthermore, in case of any out of range value, this research double checks the value by going back to the original questionnaire.

6.2.2 Data Screening

In order to make sure that all the data are entered correctly and that all the variables are normally distributed, this research conducted data screening to identify any missing data, normality and outliers. The following sections explain this preliminary analysis.

6.2.3 Treatment of Missing Data

Tabachnick and Fidell (2007, p. 62-63) explain two ways for evaluating missing data when respondents fail to answer one or more questions in a survey. The first way is associated with pattern missing data in which the researcher determines the source of the missing data based on random or non-random (i.e., related to specific items) occurrence. In other words, if the missing data is randomly distributed among the questionnaire, then there is no bias. However, if the missing data is non-randomly distributed among the questionnaire, then generalisability of results might be affected. The second way is associated with the amount of missing data. Even though Tabachnick and Fidell (2007) emphasise the above ways, they argue that pattern missing data is more important than the amount of the missing data.

Data screening reveals less than 5% missing values for each construct questions, a percentage which Churchill (1979) considers as acceptable. Randomness of the missing data was assessed to ensure that there is no systematic error (Hair *et al.*, 2006). SPSS results indicate that the pattern of missing data occurred based on randomness (missing completely at random (MCAR), $p > .05$, $p = .573$). Thus, it seems that there is no problem with the data and we can proceed for further analysis (Tabachnick and Fidell, 2007). This research replaces the missing values with the variable mean. This method is considered to be one of the best ways to replace missing data (Tabachnick and Fidell, 2007) since it is based on valid responses (Hair *et al.*, 2006).

6.3 ASSESSMENT OF NORMALITY, LINEARITY, MULTICOLLINEARITY AND OUTLIERS FOR 3D AND 2D PRODUCT VISUALISATIONS CONSTRUCTS

6.3.1 Normality

After coding the data, a normality test has been conducted to ensure that the data has not violated the normality assumption. This thesis focused on the Jarque-Bera (skewness-kurtosis) test to insure that all the constructs are within the acceptable limit of the skewness-kurtosis ranges (Table 6.1). Skewness-kurtosis tests provide a comparison of the distributions of the research data and the normal distribution (Hair *et al.*, 2006). On the one hand, skewness provides an indication about the balance and the symmetry of the distribution (i.e., whether the distribution is shifted to one side). For example, if the distribution has positively skewed values, i.e., the values are clustered to the left of the distribution; this indicates a positive skew (Hair *et al.*, 2006, p. 80). On the other hand, kurtosis provides an indication about the height of the distribution "peakedness" or "flatness". Positive kurtosis values indicate a peaked distribution, and negative kurtosis values suggest a flatter distribution (Hair *et al.*, 2006, p.80). Skewness-kurtosis critical values have been identified by previous scholars (e.g., Hair *et al.*, 2006; Tabachnick and Fidell, 2007) within the range of ± 2.58 at the 0.01 significance level. The constructs' skewness and kurtosis values, as explained in Table 6.1, lie between the recommended critical values, indicating that the data are (univariate) normally distributed. Moreover, this thesis conducted normal probability plots for each construct alone, and the results still revealed no severe deviation from normality. In other words, normal probability plots results indicated that transformation of the data is not necessary (Tabachnick and Fidell, 2007).

Table 6.1 The research constructs mean, standard deviation, variance, skewness and kurtosis

Construct	Mean		Std. deviation	Variance	Skewness		Kurtosis	
	Statistic	Std error			statistics	Std. error	statistics	Std. error
Total 3D control	29.5032	.22069	3.89822	15.196	-.817	.138	.883	.275
Total 3D animated colours	23.7083	.20366	3.59727	12.940	-.512	.138	.268	.275
Total 3D authenticity 3D	18.4359	.23426	4.13779	17.121	-.541	.138	-.188	.275
Total 3D telepresence	12.0096	.20225	3.57239	12.762	-.151	.138	-.883	.275
Total 3D hedonic	37.8718	.45573	8.04986	64.800	-.454	.138	.180	.275
Total 3D utilitarian	24.3141	.21298	3.76189	14.152	-.634	.138	.383	.275
Total 3D behavioural intention	40.3429	.36039	6.36568	40.522	-.817	.138	.973	.275
Total 2D hedonic	31.1827	.44747	7.90388	62.471	.045	.138	.175	.275
Total 2D utilitarian	24.6603	.22881	4.04158	16.334	-1.160	.138	2.245	.275

Source: Analysis of survey data (SPSS file).

6.3.2 Linearity and Multicollinearity

This research, based on the research questions, examines two sets of data. The first relates to using 3D sites, and the other to using 2D sites. To test the linearity of the relationships between variables, this research uses the bivariate correlation matrix at the 0.01 significance level (2-tailed) to determine the linearity and multicollinearity of 3D visualisation constructs. Table 6.2 and Figure 6.1 show that the independent variables are not highly correlated with each other (i.e., Pearson's correlation, r is below .7), indicating that multicollinearity between 3D product visualisation constructs is unlikely.

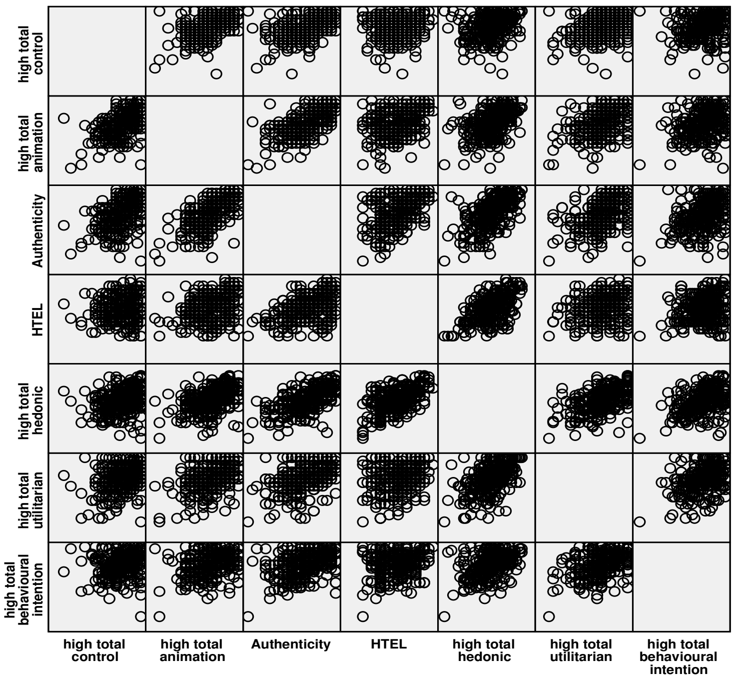
Table 6.2 3D constructs correlation and Pearson's correlation

contrasts	Total 3D control	Total 3D animated colours	Total 3D authenticity	Total 3D telepresence	Total 3D hedonic	Total 3D utilitarian	Total 3D behavioural intention
Total 3D control	1						
Total 3D animated colours	.556(**)	1					
Total 3D authenticity	.490(**)	.676(**)	1				
Total 3D telepresence	.164(**)	.320(**)	.475(**)	1			
Total 3D hedonic	.033(**)	.454(**)	.610(**)	.585(**)	1		
Total 3D utilitarian	.345(**)	.468(**)	.488(**)	.236(**)	.536(**)	1	
Total 3D behavioural intention	.216(**)	.310(**)	.403(**)	.210(**)	.418(**)	.417(**)	1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Analysis of survey data (SPSS file)

Figure 6.1 3D sites constructs scatter plot matrix



Source: Analysis of survey data (SPSS file)

6.3.3 Linearity and Multicollinearity for 2D Product Visualisation Constructs

To test the linearity of the relationships between the 2D (static) sites variables, this research uses the bivariate correlation matrix at the 0.01 significance level (2-tailed) to determine the linearity and multicollinearity of the 2D product visualisation constructs. Table 6.3 shows that the independent variables are not highly correlated with each other (i.e., r is below .7), indicating that multicollinearity between the 2D product visualisation constructs is unlikely.

Table 6.3 2D constructs correlation, Pearson's Correlation

contrasts	Total 2D hedonic	Total 2D utilitarian
Total 2D hedonic	1	
Total 2D utilitarian	.280(**)	1

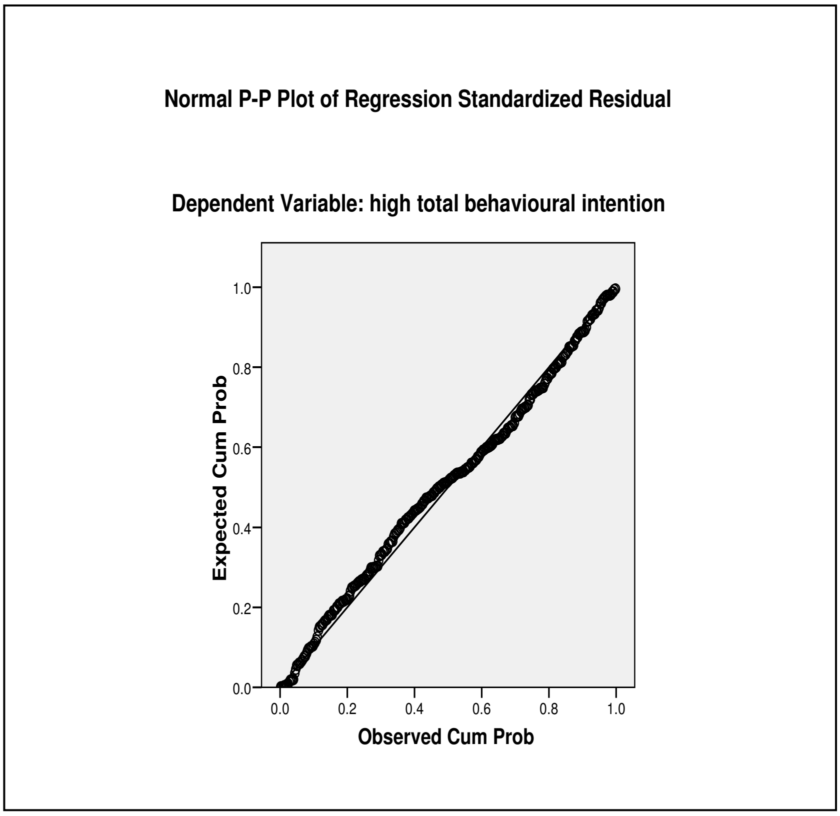
** Correlation is significant at the 0.01 level (2-tailed).
Source: Analysis of survey data (SPSS file)

6.3.4 Outliers: Univariate and Multivariate

In examining the constructs, this research detected univariate and multivariate outliers. First, this thesis started by detecting the univarite residual using box and whisker, and normal probability plot. The univarite outlier analysis revealed a few cases with large standardised scores (± 3.0). Since the sample size is large (n= 312), a few cases with outliers are expected (Tabachnick and Fidell, 2007). As a result, this thesis left the outliers for further analysis. Second, multivariate outliers were detected using the Mahalanobies distance test. The resulting R^2 value was small (.245), with a tolerance reading of (1- R^2) 0.755, indicating that the outliers has little effect on the rest of the independent variables (Hair *et al.*, 2006). Moreover, only three cases appeared to have Mahalanobis D^2 with a probability less than or equal to 0.001. Thus, this thesis decided that the multivariate outliers were random and there was less danger in retaining them (Tabachnick and Fidell, 2007). Moreover, this thesis calculated the expected normal probability results (Figure 6.2) by using the normal P-P plot of the regression standardised residual. The results revealed a multivariate normality.

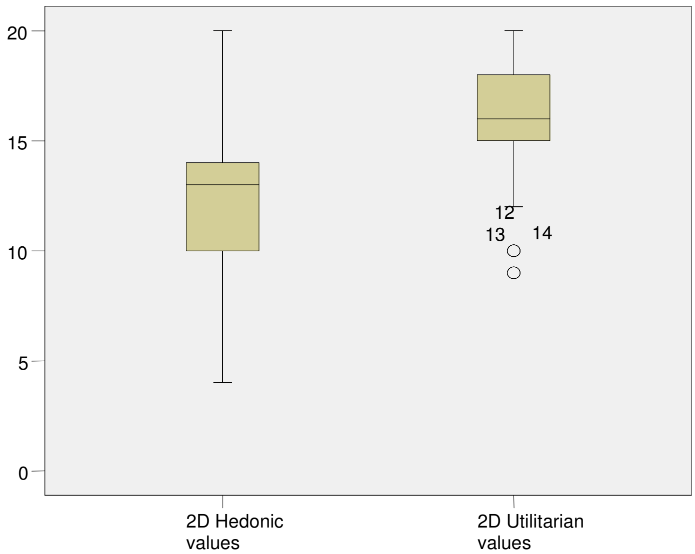
In examining the outliers for the 2D sites, this research detected univariate outliers. The univarite outlier analysis (Figure 6.3), using box and whisker, revealed a few cases with large standardised scores (± 3.0). After reviewing the outliers, this thesis concluded it was not necessary to transform any data since Tabachnick and Fidell (2007) considered a few cases with outliers as acceptable.

Figure 6.2 Normal P-P plot of regression standardised residual



Source: Analysis of survey data (SPSS file)

Figure 6.3 2D sites outliers



6.3.5 Response Rate

350 questionnaires were returned during the data collection time which started on 1st November and ran to December the 22nd (2008), 33 questionnaires were

excluded due to more than 40% of the questions incomplete. 312 participants completed the questionnaires, representing a response rate of 89.1%.

6.3.6 Sample Characteristics

Table 6.4 shows the demographics of the respondents including whether they are using the internet for e-shopping or not, number of times they bought laptops online, number of years of using the internet, frequency of using the internet for surfing e-retailers per week, gender, marital status, age, level of education, income, cultural background, educational background and studying background. Table 6.4 shows a gender balance; male (53.2%) to female (47.8%). Numbers of laptops bought online per participant ranged as follows; zero (60.6%), once (25.6%), twice (8.7%), three (4.2%), and more than three (1%). The sample ages ranged as follows; 20 or under 20 years old (41.7%), 21-30 years old (48.4%), 31-40 years old (9.6%) and 41-50 (0.3%). Annual income fluctuated as follows, under £ 15,000 (79.2%), from £ 15,000-24,000 (12.5%), from £ 25,000-34,000 (3.5%), from £ 35,000-44,000 (2.5%) and above £ 45,000 (2.3%). With regard to using the Internet for shopping, 84.9% of the sample used the Internet for e-shopping and 15.1 % did not. Moreover, 90.7% of the sample have been Internet users for more than two years.

In terms of using the Internet for surfing e-retailers per week, 14% of the sample do not surf e-retailers, 50.3% surfing them from one to two hours per week, 18.3% surfing them from 3-4 hours per a week and 17.3% surfing them more than 4 hours a week. In regard to level of education, 58.7% of the sample are undergraduate students, 25.8% are postgraduate students and 11.8% are PhD students. The sample possesses different types of laptops, for example, HP, Dell and Toshiba have the highest percentage (19.8%, 15.7%, and 11.9% respectively), and 13.5% of the sample have no laptop. In terms of marital status, 86.5% of the sample are singles, 12.2% are married and 1.3% are divorced. In regard to the country that best described the participants' cultures, UK, UK-Asian, UK-African, UK-EU and Asian represent the highest percentages (15.4%, 26.9%, 12.2%, 9% and 26.6% respectively) among the sample. This multi-cultural diversification represents the metropolitan nature of London's culture. In terms of the study background, the sample represents four main subjects as follows; Business (28.8%), Social Science (26.3), Maths and IT (23.1%) and Engineering (21.8%).

Table 6.4 Demographics of the respondents

Demographic profile	Number of respondent N= 312	Valid percentage
Using Internet for e-shopping:		
Yes	265	84.9
No	47	15.1
Number of buying a laptop online:		
no	189	60.6
once	80	25.6
twice	27	8.7
three	13	4.2
others	3	1
Laptops available at the moment:		
I have not	42	13.5
Sony	50	16
HP	59	19.8
Dell	49	15.7
Toshiba	37	11.9
Acer	13	4.2
Compaq	9	2.9
ASUS	15	4.8
Apple	13	4.2
IBM	7	2.2
Siemens	3	1.0
Samsung	7	2.2
Others	8	2.6
Using Internet:		
Do not use	1	.3
Less than 1 year	10	3.2
1-2 years	18	5.8
More than 2 years	283	90.7
Internet for surfing e-retailers per week:		
Don't	44	14.1
1-2 hours	157	50.3
3-4 hours	57	18.3
More than 4 hours	54	17.3
Gender:		
Male	162	53.2
Female	149	47.8
Marital status:		
Single	270	86.5
Married	38	12.2
Divorced	4	1.3
Separated	0	0
others	0	0
Age:		
20 or under	130	41.7
21-30	151	48.4
31-40	30	9.6
41-50	1	0.3
51-60	0	0
61+	0	0
Level of education:		
Undergraduate	183	58.7
Postgraduate	89	28.5

PhD student PhD holder	34 6	10.9 1.9
Annual income: Under 14,999 15,000 -24,999 25,000 -34,999 35,000 -44,999 45,000 +	 247 39 11 8 7	 79.2 12.5 3.5 2.6 2.3
Country that best describes the participants cultures: UK UK-ASIA UK-AFRICA UK-EU EU ASIA AFRICA USA	 48 84 38 28 5 83 23 3	 15.4 26.9 12.2 9.0 1.6 26.6 7.4 1.0
Study background: Business school Social science school Maths and IT school Engineering school	 90 82 72 68	 28.8 26.3 23.1 21.8

Source: Analysis of survey data (SPSS file)

6.4 FACTOR ANALYSIS (EXPLORATORY FACTOR ANALYSIS)

This thesis employs the maximum likelihood factoring method, a type of common factor analysis, as the main extraction method for the following reasons (Hair *et al*., 2006). First, in comparison to the principal factor method (another type of common factor analysis), the maximum likelihood factoring method produces a better estimate than the principal factor method (in a large sample size) and it has desirable asymptotic properties (Bickel and Doksum, 1977). In addition, most statisticians prefer using the maximum likelihood factor analysis over the principal factor analysis because the former relatively require a multivariate normal distribution (Geweke and Singleton, 1980). Second, unlike the principal component analysis, which considers the total variance (i.e., common, unique and error variances), the maximum likelihood method examines only the common variance (Hair *et al*., 2006; Tabachnick and Fidell, 2007). Third, the maximum likelihood factoring method treats the correlation matrix as a sample correlation matrix. Fabrigar and colleagues (1999, p. 277) argue that if the data are relatively normally distributed, the maximum likelihood factoring method is the best choice as "it allows for the computation of a wide range of indexes of the goodness of fit of the model [and] permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals.” To ensure the dependency of the constructs, a correlation matrix has been produced to test the associations with each construct. Results of the bivariate correlation matrix revealed that the constructs are not highly correlated with each other (r is below .7, indicating that multicollinearity is unlikely, see Table 6.1). Moreover, results of the pattern matrix (exploratory factor analysis, Table 6.7) shows the constructs are not cross-loaded with each other, and it indicates a separation between the constructs. Furthermore, the results of the confirmatory factor analysis posit that cross-loading between constructs is not possible and that each construct is converged with its own items (Tables, 6.31-6.36). Finally, this thesis conducts a discriminant validity to make sure that each construct stands alone and there is no interaction with other constructs (Table, 6.37).

Field (2005) recommends researchers follow three tests to determine the adequacy of the extraction method in a factor analysis. The Kaiser-Meyer-Olkin (KMO) test of sampling adequacy, eigenvalue, and the Bartlett’s test of sphericity. To identify whether the factor analysis extraction method is acceptable, Field (2005) asserts that if the number of variables used in a factor analysis is less than 30, sample size is above 250, the average communality is greater than or equal to 0.6, and the Bartlett’s test of sphericity is significant, then the factor analysis extraction method is accepted. All of the above conditions applied to this research; the KMO of sampling adequacy is .909 (i.e., .6 and above is acceptable, according to Tabachnick and Fidell, 2007), and the Bartlett’s Test of Sphericity is significant ($p < .001$). The KMO and Bartlett’s test of sphericity results (Table 6.5) support the factorability of the correlation matrix and indicate that the factor analysis is appropriate. However, the average communalities in this research was .59 which is a bit lower than Field (2005) recommends as an appropriate ratio. Notwithstanding, Field (2005) advises researcher to follow Stevens’ (1996) method if the average communalities value is below 0.6. Stevens’ (1996) method is based on the scree plot method and aims to determine how many factors should be retained. When this research ran the scree plot method, the result showed a clear break between the sixth and the seventh factors. Moreover, the first six factors explained much more of the variance than the remaining factors. To confirm this result, this research conducts reproduced correlations for the percentage of non-redundant residuals with absolute value >.05, and the percentage was found to be less than 50% (it was exactly 4%) which indicates that there is no need to retain any more factors.

Table 6.5 KMO and Bartlett's Test

Kaiser-Meyer-Olkin measure of sampling adequacy.		.909
Bartlett's Test of Sphericity	Approx. Chi-Square	4905.060
	Df	378
	Sig.	.000

Table 6.6 Goodness-of-fit Test

Chi-Square	df	Sig.
404.458	225	.000

6.4.1 Factor Loading

This research follows the instructions of previous scholarly literature (e.g., Hair *et al*., 2006; Tabachnick and Fidell, 2007) to identify the appropriate loading between a variable and its factors (i.e., for each variable on each factor). Following Hair *et al*.'s (2006) procedures for identifying a significant factor loading and based on the research sample size (n = 312 students), the appropriate factor loading as suggested by Hair *et al*. (2006) should be 0.3 and above at the 0.05 significance level. See Table 6.7.

The results of the rotation method show that SPSS rotated six factors, all loadings above .30. This research employs the direct oblimin rotation; an oblique approach which assumes that the factors are correlated and it considers the factors related to them (Hair *et al*., 2006; Tabachnick and Fidell, 2007). The pattern matrix (Table 6.7) shows the six rotated factors; the 3D authenticity construct explains 33.654% of the total variance, the behavioural intention construct explains 7.432% of the total variance, the utilitarian values construct explains 5.808% of the total variance, the hedonic values construct explains 5.104% of the total variance, the control construct explains 4.092% of the total variance, and finally, the animated colours construct explains 2.935% of the total variance. See Table 6.8.

Table 6.7 Rotated component matrix: pattern matrix

	Factor					
Items	1	2	3	4	5	6
3D Authenticity 3	.893					
3D Authenticity 2	.716					
3D Authenticity 4	.512					
3D Authenticity 5	.497					
3D Behavioural intention 3		.855				
3D Behavioural intention 4		.811				
3D Behavioural intention 2		.794				
3D Behavioural intention 5		.728				
3D Utilitarian value 3			.862			
3D Utilitarian value 2			.752			
3D Utilitarian value 4			.717			
3D Utilitarian value 5			.626			
3D Hedonic value 4				-.851		
3D Hedonic value 3				-.821		
3D Hedonic value 2				-.638		
3D Hedonic value 5				-.631		
3D Control4					.842	
3D Control 5					.716	
3D Control 3					.581	
3D Control 2					.465	
3D Animated colour 5						.652
3D Animated colour 4						.493
3D Animated colour 3						.455
3D Animated colour 6						.407

Source: Analysis of survey data (SPSS file)

Table 6.8 Total variance explained

Factor	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.535	35.564	35.564	8.077	33.654	33.654	5.114
2	2.298	9.577	45.141	1.784	7.432	41.086	4.549
3	1.731	7.214	52.355	1.394	5.808	46.894	4.688
4	1.670	6.960	59.314	1.225	5.104	51.998	5.157
5	1.225	5.104	64.419	.982	4.092	56.090	3.857
6	1.118	4.658	69.077	.704	2.935	59.024	3.637
7	.748	3.116	72.193				
8	.699	2.912	75.105				
9	.625	2.606	77.711				
10	.561	2.336	80.048				
11	.526	2.190	82.238				
12	.481	2.005	84.243				
13	.452	1.883	86.125				
14	.438	1.825	87.950				
15	.398	1.657	89.607				
16	.381	1.588	91.195				
17	.360	1.501	92.696				
18	.300	1.248	93.944				
19	.294	1.225	95.169				
20	.284	1.181	96.350				
21	.262	1.092	97.442				
22	.241	1.003	98.445				
23	.206	.856	99.302				
24	.168	.698	100.000				

a When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

Source: Analysis of survey data (SPSS file)

6.5 STAGE 1

6.5.1 3D Authenticity Vs 3D Telepresence

To answer the first research question, this thesis conducted a one-way repeated measure ANOVA to compare the scores of 3D telepresence and 3D authenticity constructs. Table 6.9 shows the mean, standard deviation and number of participants used in Stage 1. 312 participants were employed to conduct this experiment. Participants agreed that the 3D site is best represented by 3D authenticity (M = 18.44, SE = .224) rather than by 3D telepresence (Mean, M = 12.010, Standard deviation, SE = .125), i.e., by a sense of being transported into another place. The Wilks' Lambda is .2764, F (1,311) = 814.078, *($p < .001$)*, and the multivariate eta squared is .724, which reflects a very large effect size (Cohen, 1988). The results of the post hoc analysis (as explained in the pairwise comparisons) also reveal that 3D authenticity is more significant than 3D telepresence ($p < .001$).

Table 6.9 Within-subjects factors, 3D telepresence and 3D authenticity

Within-subjects factors		Descriptive statistics N = 312	
Visualisation type	Dependent variable	Mean	Standard deviation
1	3D Authenticity	18.4359	4.13779
2	3D Telepresence	12.0096	3.57239

Table 6.10 shows the pairwise comparisons for the main effects of the 3D authenticity and 3D telepresence constructs (corrected using a Bonferroni adjustment to control the error rate). Table 6.10 indicates a significant difference ($p < .001$) between the 3D authenticity and 3D telepresence constructs (i.e., level 1 vs. level 2). Moreover, Table 6.10 indicates a significant difference between the 3D telepresence construct and the 3D authenticity construct (i.e., level 2 vs. level 1). A look at the mean difference tells the reader that the difference is negative. In other words, if the 3D telepresence construct is used in comparison to the 3D authenticity construct to illustrate how consumers perceived a laptop, then the mean will decrease by 6.426 units. Using the 3D authenticity construct will often give a positive mean difference in comparison to using the construct of 3D telepresence. This stage answered the first research question and supported H_1. This research highlights the importance of the 3D authenticity construct, not the 3D telepresence construct, in simulating a 3D product visualisation. Participants agreed that the 3D site was authentic, not a state of being transported into other places (i.e., telepresence). See Figure 6.4.

Table 6.10 Visualisation levels, post hoc tests, pairwise comparisons

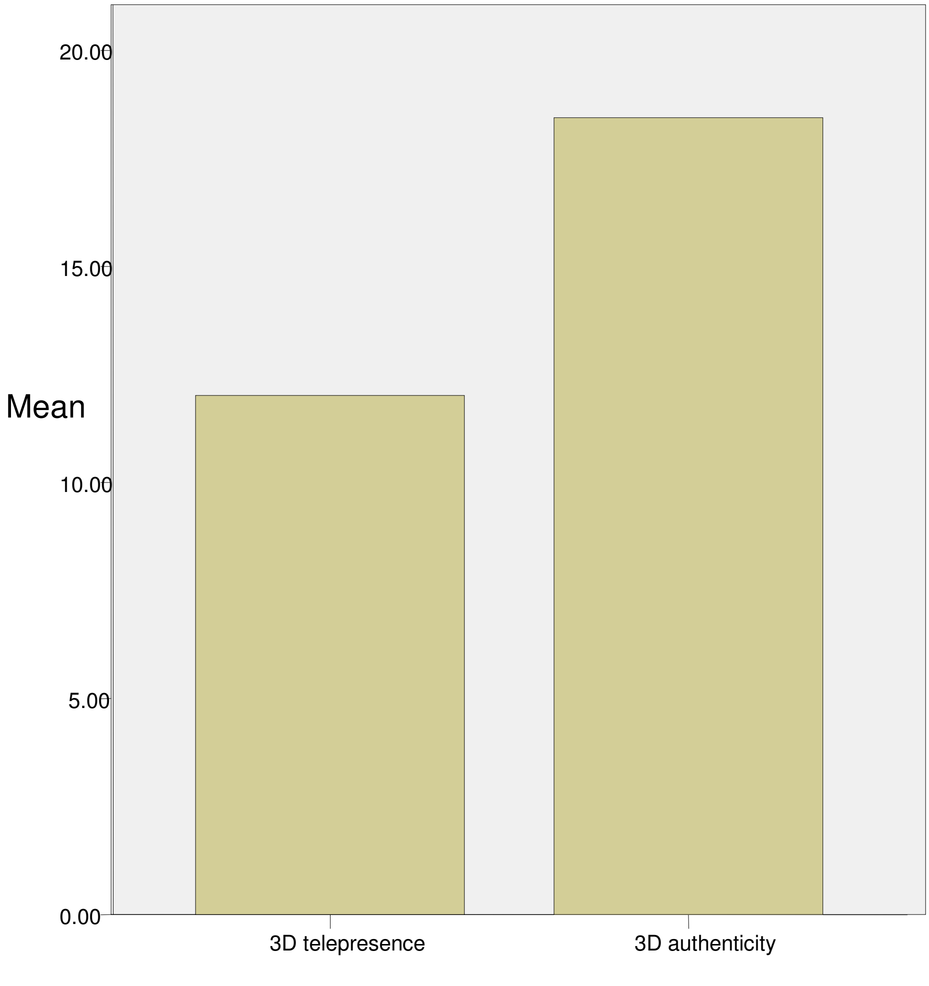
(I) Visualisation	(J) Visualisation	Mean difference (I-J)	Std. error	Sig.[a]	95% confidence interval for bifference[a]	
					Lower bound	Upper bound
1	2	6.426 *	.225	.000	5.983	6.869
2	1	-6.426 *	.225	.000	-6.869	-5.983

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Figure 6.4 Mean of 3D telepresence and 3D authenticity



6.6 STAGE 2: 3D AND 2D EXPERIENCE (HEDONIC AND UTILITARIAN VALUES)

A series of one-way repeated measure ANOVAs has been conducted to determine the main influences of hedonic and utilitarian effects when using 3D and 2D sites. Stage 2 aims at two objectives. First, comparing the hedonic values produced from using 3D sites in comparison to the 2D sites. Second, comparing the utilitarian values produced from using 3D sites in comparison to the 2D sites.

6.6.1 3D and 2D Experience Hedonic Values

Pre-Test (Manipulation Check)

The manipulation check results revealed that participants (n = 30) noticed the different levels of each site, they perceived the 3D website that gave more entertainment (ability to zoom in or out, rotate and change the colours of a laptop) about the laptops as significantly more hedonic than the 3D website which produced less entertainment (i.e., the laptop only rotates and in one colour) ($M_{\text{3D high hedonic}} = 14.933$, $M_{\text{3D low hedonic}} = 8.733$; $F_{1, 29} = 63.243$, $p < .001$). Moreover, they perceived the 2D website which gave more entertainment about the laptops to be significantly more hedonic than the 2D website ($M_{\text{2D high hedonic}} = 11.9$, $M_{\text{2D low hedonic}} = 9.167$; $F_{1, 29} = 14.384$, $p < .01$).

Results

Table 6.11 shows the mean, the standard deviation and number of participants used in Stage 2. 312 participants were employed to conduct this experiment. Participants have agreed that the 3D sites are providing more hedonic values (M = 14.509, SE = 3.163) than the 2D sites (M = 12.28, SD = 3.110). The Wilks' Lambda is .790, F (1,311) = 82.521, ($p < .001$), and the multivariate eta squared is .210, which reflects a very large effect size (Cohen, 1988). The results of the post hoc analysis (Table 6.12) also reveal that the 3D sites provide users with more hedonic values than the 2D sites do ($p < .001$). The results of this stage answered the second research question and supported H_2. Participants perceived 3D sites to be more hedonic than 2D sites (Figure 6.5).

Table 6.11 Within-subjects factors, 3D and 2D hedonic.

Within-Subjects Factors		Descriptive statistics N = 312	
Hedonic source	Dependent variable	Mean	Standard deviation
1	Hedonic of 3D sites	14.5096	3.16328
2	Hedonic of 2D sites	12.2788	3.11037

Table 6.12 Hedonic levels pairwise comparisons

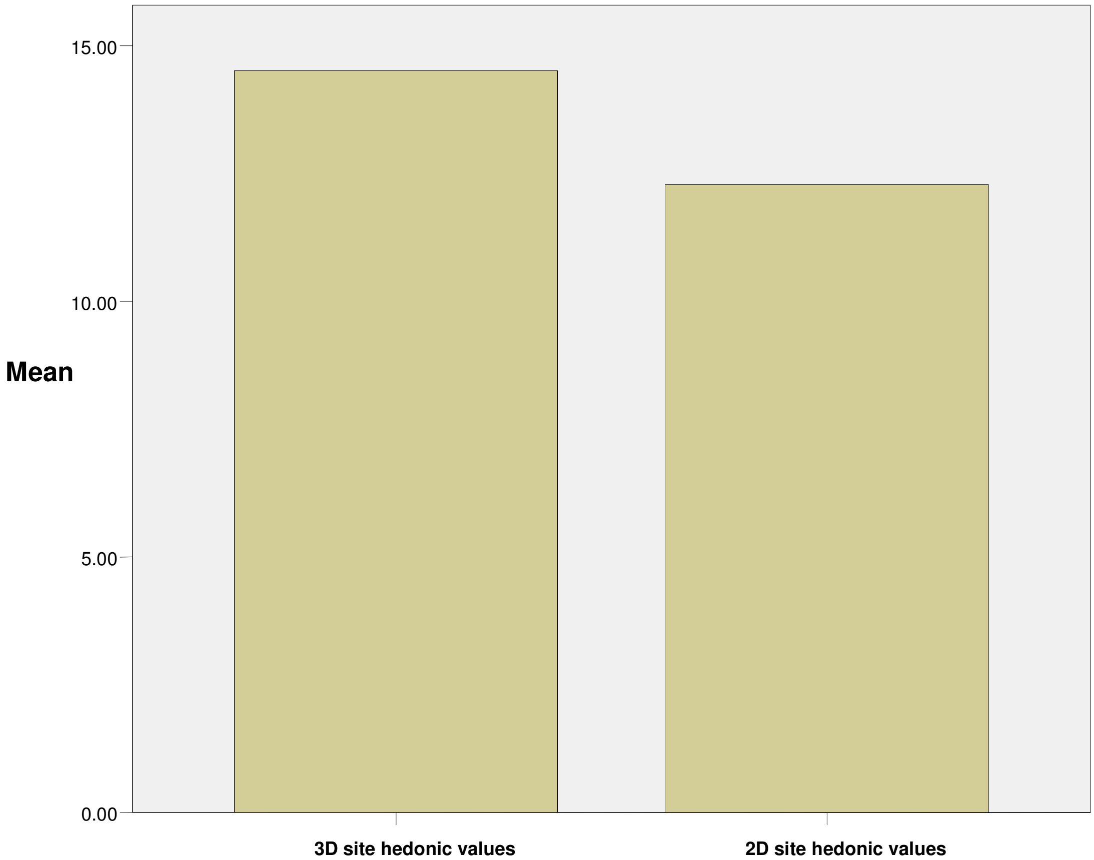
(I) Hedonic	(J) Hedonic	Mean difference (I-J)	Std. error	Sig. [a]	95% confidence interval for difference [a]	
					Lower bound	Upper bound
1	2	2.231 *	.246	.000	1.748	2.714
2	1	-2.231 *	.246	.000	-2.714	-1.748

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Figure 6.5 Mean of 2D hedonic and 3D hedonic.



6.6.2 3D and 2D Utilitarian Values

Another one-way repeated measure ANOVA has been conducted to determine the main influences of utilitarian values in 3D sites and 2D sites. This experiment aims to compare the utilitarian values produced from using 3D sites in compression to 2D sites.

Pre-Test (Manipulation Check)

The manipulation check results revealed that participants (n = 30) noticed the different levels of each site. They perceived the 3D website which gave more information about the laptops as significantly more utilitarian than the 3D website that gave less information ($M_{\text{3D high utilitarian}} = 16.7$, $M_{\text{3D low utilitarian}} = 8.96$; $F_{1, 29} = 96.02$, $p < .001$). Moreover, they also perceived that the 2D website which gave more information about the laptops to be significantly more utilitarian than the 2D website that gave less information ($M_{\text{2D high utilitarian}} = 15.96$, $M_{\text{2D low utilitarian}} = 11.93$; $F_{1, 29} = 19.8$, $p < .001$).

Results

Table 6.13 shows the mean, standard deviation and number of participants used in this experiment. 312 participants were employed to conduct this experiment. Participants exposed to the designed websites agreed that the 3D site gives as much information (M=16.2115, SD= 2.624) as the 2D site does (M=16.4583, SD= 2.72). The Wilks' Lambda is .996, F (1,311) = 1.387, (p = *.240)*, and the multivariate eta squared is .004, which reflects a very small effect size (.01 or less, Cohen, 1988). The results of the post hoc analysis (Table 6.14) also reveal that 3D utilitarian and 2D utilitarian are insignificantly different *(*p > .05*)*. The results of the above stage (experiment) answered the third research question and supported H_3. The participants perceived similar presentation of information when using both 3D and 2D sites (Figure 6.6).

Table 6.13 Within-subjects factors, 3D and 2D utilitarian

Within-subjects factors		Descriptive statistics N = 312	
Utilitarian source	Dependent variable	Mean	Standard deviation
1	Utilitarian of 3D sites	16.2115	2.62442
2	Utilitarian of 2D sites	16.4583	2.72151

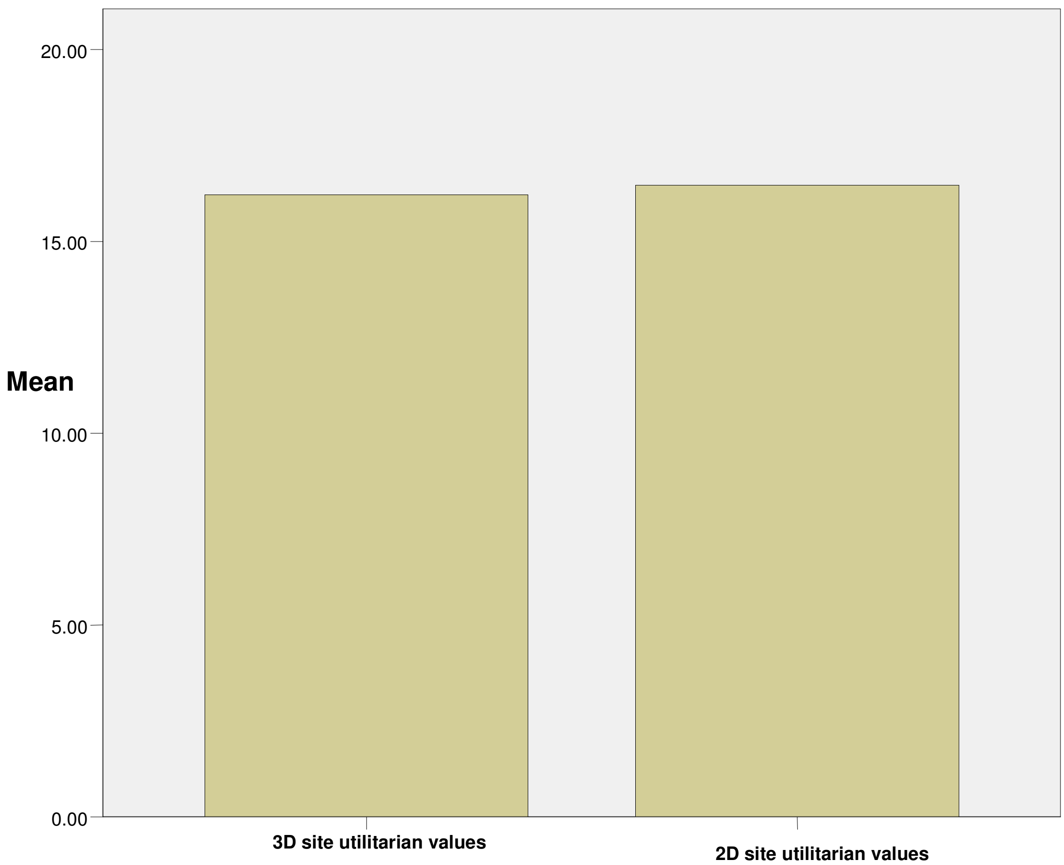
Table 6.14 Utilitarian levels pairwise comparisons

(I) Utilitarian	(J) Utilitarian	Mean difference (I-J)	Std. error	Sig. [a]	95% confidence interval for difference [a]	
					Lower bound	Upper bound
1	2	-.247	.210	.240	-.659	.166
2	1	.247	.210	.240	-.166	.659

Based on estimated marginal means.

a. Adjustment for multiple comparisons: Bonferroni.

Figure 6.6 Mean of 2D utilitarian and 3D utilitarian.



6.7 STAGE 3: STATISTICAL ANALYSES OF THE CONTROL AND ANIMATED COLOURS PROGRESSIVE LEVELS.

This stage aims to answer the fourth research question and to test $H_{4,}$ regarding the effect of the progressive levels of control and animated colours on 3D authenticity construct.

6.7.1 Manipulation Checks (Pre-Test)

The manipulation check results revealed that participants (n = 30) noticed the different levels of each construct. They perceived that the 3D website where they could zoom in or out and rotate as being significantly more controllable than the 3D website where they had no control of the zoom and rotation ($M_{\text{high control}}$ = 15.9, $M_{\text{low control}}$ = 9.5; $F_{1, 29}$ = 116.4, $p < .001$). Moreover, participants perceived the website with more colours to be significantly more colourful than the website with one colour ($M_{\text{high colours}}$ = 11, $M_{\text{low colours}}$ = 6.4; $F_{1, 29}$ = 45.43, $p < .001$).

6.7.2 Results of the Control and Animated Colours Progressive Levels

This thesis ran a two-way within-subjects design-repeated measures ANOVA to compare the scores for the two levels of control and two levels of animated colours, 2 (control: high *vs*. low) × 2 (colour: high *vs*. low), with the 3D authenticity construct as the dependent variable. Table 6.15 shows the progressive levels of control and animated colours (1 = a high level and 2 = a low level). Participants used five-point Likert scales to indicate their agreement or disagreement on the authenticity of the presented sites. Twenty four participants were employed to discover the main effects of each condition and the interaction effects.

Table 6.15 shows the descriptive statistics of the observed means and the standard deviations for each condition. Participants exposed to the condition with high control and high animated colours agreed that the site attained high authenticity (M = 19.58, SD = 3.54), but the site with low levels of control and animated colours achieved a low level of authenticity (M = 10.08, SD = 3.74). The high level of control and low level of animated colours (M = 14.41, SD =

4.49), and the low level of control and high level of animated colours (M =13.25, SD = 3.54) also prompted ratings of a low level of authenticity.

Table 6.15 Within-subjects factors, progressive levels of control and animated colours

(2×2) Within-subjects factors			N = 24	Descriptive statistics	
Control	Animated colours	Explanation	Dependent variable	Mean	Std. deviation
1	1	High control, high animated colours	3D Authenticity	19.5833	3.54985
	2	High control, low animated colours	3D Authenticity	14.4167	4.49073
2	1	low control, high animated colours	3D Authenticity	13.2500	3.54168
	2	low control, low animated colours	3D Authenticity	10.0833	3.74069

Table 6.16 shows tests of within-subjects effects. The table shows the main effects of each construct, the effects of control and animated colours interactions, and the error terms associated with these effects. This thesis found that the main effect of the control construct is significant, a Wilks' Lambda value of: .275, F (1, 23) = 60.778 (p < .001), and an eta squared value of .725 (which is a large effect size according to Cohen, 1988). The main effect of animated colours also is significant, with a Wilks' Lambda of: .40, F (1, 23) = 34.6 (p < .001), and an eta squared value of .60. The results also indicate an insignificant interaction effect between the manipulated constructs (control × animated colours; F (1, 23) = 2.272, $p > .05$, $eta^2 = .090$). The results of the above stage (experiment) answered the fourth research question, and supported H_4. The following illustrates the effect of each variable if the other variable is ignored.

Table 6.16 Tests of within-subjects effects (control and animated colours)

Source		Type III sum of squares	df	Mean square	F	Sig.
Control	Sphericity assumed	682.667	1	682.667	60.779	.000
	Greenhouse-Geisser	682.667	1.000	682.667	60.779	.000
	Huynh-Feldt	682.667	1.000	682.667	60.779	.000
	Lower-bound	682.667	1.000	682.667	60.779	.000
Error(Control)	Sphericity assumed	258.333	23	11.232		
	Greenhouse-Geisser	258.333	23.000	11.232		
	Huynh-Feldt	258.333	23.000	11.232		
	Lower-bound	258.333	23.000	11.232		
Animated colours	Sphericity assumed	416.667	1	416.667	34.555	.000
	Greenhouse-Geisser	416.667	1.000	416.667	34.555	.000
	Huynh-Feldt	416.667	1.000	416.667	34.555	.000
	Lower-bound	416.667	1.000	416.667	34.555	.000
Error(Animated colours)	Sphericity assumed	277.333	23	12.058		
	Greenhouse-Geisser	277.333	23.000	12.058		
	Huynh-Feldt	277.333	23.000	12.058		
	Lower-bound	277.333	23.000	12.058		
Control * Animated colours	Sphericity assumed	24.000	1	24.000	2.272	.145
	Greenhouse-Geisser	24.000	1.000	24.000	2.272	.145
	Huynh-Feldt	24.000	1.000	24.000	2.272	.145
	Lower-bound	24.000	1.000	24.000	2.272	.145
Error(Control* Animated colours)	Sphericity assumed	243.000	23	10.565		
	Greenhouse-Geisser	243.000	23.000	10.565		
	Huynh-Feldt	243.000	23.000	10.565		
	Lower-bound	243.000	23.000	10.565		

Computed using alpha = .05

Source: Analysis of survey data (SPSS file)

6.7.2.1 *The Effect of the Control Construct*

Table 6.17 shows the effect of the control levels used in rating the 3D authenticity construct. The means (M) and standard errors (SE) of the control levels are as follows: $M_{high} = 17$, $SE_{high} = .55$, $M_{low} = 11.7$ and $SE_{low} = .68$. The effect of control levels tells us that if we ignore the animated colour levels that were used in the analyses, participants still rate some levels of the control construct significantly differently (Table 6.18). Moreover, it is clear from the table that the high level of control (1) rated higher than the low level of control (2).

Table 6.17 The effect of control levels

Control level	Mean	Std. Error	95% confidence interval Lower bound	Upper bound
(1) High	17.00	.551	15.860	18.140
(2) Low	11.667	.679	10.262	13.071

Table 6.18 shows the pairwise comparisons for the main effect of control construct levels (corrected using a Bonferroni adjustment to control the error rate[5]). This table indicates that the significant main effect of control construct reflects a significant difference ($p < .001$) between levels 1 and 2 (i.e., the high control and low control respectively). Moreover, the table indicates a significant difference between the low control and high control levels (i.e., level 2 *vs.* level 1). A look at the mean difference tells the reader that the difference is negative. In other words, the 3D authenticity construct mean will decrease by 5.333 units if we used the low control level in comparison to the high level.

[5] Bonferroni contrasts were used to determine which levels were responsible for the observed effect.

Table 6.18 The control levels pairwise comparisons

(I) Control	(J) Control	Mean difference (I-J)	Std. error	Sig. [a]	95% confidence interval for difference [a] Lower bound	Upper bound
1	2	5.333 *	.684	.000	3.918	6.749
2	1	-5.333 *	.684	.000	-6.749	-3.918

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

6.7.2.2 The Effect of the Animated Colours Construct

Table 6.19 shows the effect of the animated colours levels used in rating the 3D authenticity construct. The means (M) and standard errors (SE) of the animated colours levels are as follows: $M_{high} = 16.42$, $SE_{high} = .54$, $M_{low} = 12.25$ and $SE_{low} = .70$. The effect of the animated colours levels tells us that if we ignore the control levels that were used in the analyses, participants still rate some levels of the animated colour construct significantly differently (Table 6.20). Moreover, it is clear from the table that the high level of the animated colours (1) rated higher than the low level (2).

Table 6.19 The effects of the animated colours construct

Animated colours levels	Mean	Std. error	95% confidence interval Lower bound	Upper bound
(1) High	16.417	.535	15.311	17.523
(2) Low	12.250	.704	10.790	13.706

Table 6.20 shows the pairwise comparisons for the main effect of the levels of animated colour construct (corrected using a Bonferroni adjustment to control the error rate). Table 6.20 points out that the significant main effect of the animated colours construct reflects a significant difference ($p < .001$) between levels 1 and 2 (i.e., the high and low animated colours). Moreover, the table indicates a significant difference between the low animated and high animated colours levels

(i.e., level 2 *vs*. level 1). A look at the mean difference tells the reader that the difference is taking a minus sign. In other words, the 3D authenticity construct mean will decrease by 4.167 units if we used the low animated colours level in comparison to the high level.

Table 6.20 The animated colours levels pairwise comparisons

(I) Animation	(J) Animation	Mean difference (I-J)	Std. error	Sig.[a]	95% confidence interval for difference [a]	
					Lower bound	Upper bound
1	2	4.167 *	.709	.000	2.700	5.633
2	1	-4.167 *	.709	.000	-5.633	-2.700

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

6.8 STAGE 4: STATISTICAL ANALYSES OF THE 3D HEDONIC AND UTILITARIAN PROGRESSIVE LEVELS

This stage aims to answer the fifth research question and to test H_5 regarding the effect of the progressive levels of 3D hedonic and utilitarian values on behavioural intention.

6.8.1 Manipulation Checks (Pre-Test)

This thesis ran a series of pre-tests (n = 30) to develop the stage materials. Manipulation checks were used to test several 3D flashes based on the hedonic and utilitarian dimensions to determine whether the participants noticed the differences between the various conditions of each construct (5-point scales). The results revealed that participants noticed the different levels of each construct. They perceived the 3D website that gave more information about the laptops as significantly more utilitarian than the 3D website that gave less information ($M_{\text{high utilitarian}} = 16.7$, $M_{\text{low utilitarian}} = 8.96$; $F_{1, 29} = 96.02$, $p < .001$). Moreover, they perceived the 3D website with animated coloured pictorial images as significantly more hedonic than the 3D website in monochrome without the animated images ($M_{\text{high hedonic}} = 14.93$, $M_{\text{low hedonic}} = 8.73$; $F_{1, 29} = 63.243$, $p < .001$).

6.8.2 *Results of the 3D Hedonic and Utilitarian Constructs Progressive Levels*

This thesis ran another two-way repeated measures ANOVA to compare the scores for the two levels of hedonic and two levels of utilitarian (2×2), a within-subjects design with behavioural intention as the dependent variable. Table 6.21 shows the different levels of the hedonic and utilitarian values (1 means high level and 2 means low level) used in this stage. Participants used 5-point Likert scales to indicate their agreement or disagreement on their behavioural intentions toward the presented 3D sites. Twenty four participants have been employed to do this experiment. Table 6.21 shows the different levels of hedonic and utilitarian values constructs, the descriptive statistics of the observed means, and the standard deviations for each condition. Participants exposed to the 3D condition with high hedonic and high utilitarian values agreed that the site attained high behavioural intention scores (M = 25.2, SD = 2.93), but the 3D site with low levels of hedonic and utilitarian values achieved a low level of behavioural intention scores (M = 9.00, SD = 3.68). The high level of hedonic and low level of utilitarian (M = 15.29, SD = 4.36), and low level of hedonic and high level of utilitarian (M =10.83, SD = 4.31) also prompted ratings of a low level of behavioural intention.

Table 6.21 Within-subjects factors, progressive levels of hedonic and utilitarian constructs

Within-subjects factors				Descriptive statistics	
Hedonic	Utilitarian	Explanation	Dependent variable	Mean	Std. deviation
1	1	High hedonic, high utilitarian	Behavioural intention	25.2083	2.93375
	2	High hedonic, low utilitarian	Behavioural intention	15.2917	4.35869
2	1	Low hedonic, high utilitarian	Behavioural intention	10.8333	4.31042
	2	Low hedonic, low utilitarian	Behavioural intention	9.0000	3.68310

Table 6.22 shows tests of within-subjects effects. The table shows the main effects of each construct, the effects of the hedonic and utilitarian value interaction, and the error terms associated with theses effects. This thesis found that the main effect of the hedonic value levels is significant, a Wilks' Lambda value of: .106, F (1, 23) = 193.039 (p < .001), and an eta squared value of .894

(which is a large effect size according to Cohen, 1988). The main effect of the utilitarian value also is significant, with a Wilks' Lambda of: .203, F (1, 23) = 90.030 (p < .001), and an eta squared value of .797. The results also indicate a significant interaction effect between hedonic and utilitarian constructs, with a Wilks' Lambda of: .389, F (1, 23) = 36.074, p < .001, eta^2 = .611). The results of the above stage (experiment) answered the fifth research question, and supported H_5. The following illustrates the main effect of each variable and their interactions.

Table 6.22 Tests of Within-Subjects Effects (Hedonic and Utilitarian Values)

Source		Type III sum of squares	df	Mean square	F	Sig.
3D Hedonic	Sphericity assumed	2562.667	1	2562.667	193.039	.000
	Greenhouse-Geisser	2562.667	1.000	2562.667	193.039	.000
	Huynh-Feldt	2562.667	1.000	2562.667	193.039	.000
	Lower-bound	2562.667	1.000	2562.667	193.039	.000
Error(hedonic)	Sphericity assumed	305.333	23	13.275		
	Greenhouse-Geisser	305.333	23.000	13.275		
	Huynh-Feldt	305.333	23.000	13.275		
	Lower-bound	305.333	23.000	13.275		
3D Utilitarian	Sphericity assumed	828.375	1	828.375	90.030	.000
	Greenhouse-Geisser	828.375	1.000	828.375	90.030	.000
	Huynh-Feldt	828.375	1.000	828.375	90.030	.000
	Lower-bound	828.375	1.000	828.375	90.030	.000
Error(utilitarian)	Sphericity assumed	211.625	23	9.201		
	Greenhouse-Geisser	211.625	23.000	9.201		
	Huynh-Feldt	211.625	23.000	9.201		
	Lower-bound	211.625	23.000	9.201		
3D Hedonic * 3D Utilitarian	Sphericity assumed	392.042	1	392.042	36.074	.000
	Greenhouse-Geisser	392.042	1.000	392.042	36.074	.000
	Huynh-Feldt	392.042	1.000	392.042	36.074	.000
	Lower-bound	392.042	1.000	392.042	36.074	.000
Error(3D Hedonic* 3D Utilitarian)	Sphericity assumed	249.958	23	10.868		
	Greenhouse-Geisser	249.958	23.000	10.868		
	Huynh-Feldt	249.958	23.000	10.868		
	Lower-bound	249.958	23.000	10.868		

Computed using alpha = .05

Source: Analysis of survey data (SPSS file)

6.8.2.1 The Main Effect of the 3D Hedonic Construct

Table 6.23 shows the effect of hedonic construct levels used in rating the behavioural intention construct. The effect of the hedonic value levels tells us that if we ignore the utilitarian value levels that were used in the analyses, participants still rate some levels of the hedonic construct significantly differently (Table 6.24). Moreover, it is clear from the table that the high level of hedonic construct (1) is rated higher than the low level (2).

Table 6.23 The main effect of the 3D hedonic construct

Hedonic level	Mean	Std. error	95% confidence interval Lower bound	Upper bound
(1) High	20.250	.619	18.970	21.530
(2) Low	9.917	.666	8.539	11.294

Table 6.24 shows the pairwise comparisons for the main effect of hedonic value levels (corrected using a Bonferroni adjustment to control the error rate). This table indicates that the significant main effect of the hedonic value levels reflects a significant difference ($p < .001$) between levels 1 and 2 (i.e., the high hedonic and low hedonic). Moreover, the table indicates a significant difference between the low hedonic and the high hedonic levels (i.e., level 2 *vs.* level 1). A look at the mean difference tells the reader that the difference is negative. In other words, the behavioural intention construct mean will decrease by 10.333 units if we used the low hedonic level in comparison to the high level.

Table 6.24 Hedonic levels pairwise comparisons

(I) Hedonic	(J) Hedonic	Mean difference (I-J)	Std. error	Sig.[a]	95% confidence interval for difference [a] Lower bound	Upper bound
1	2	10.333 *	.744	.000	8.795	11.872
2	1	-10.333 *	.744	.000	-11.872	-8.795

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

6.8.2.2 The Main Effect of the Utilitarian Construct

Table 6.25 shows the effect of the utilitarian value levels used in rating the behavioural intention construct. The effect of the utilitarian value levels tells us that if we ignore the hedonic levels that were used in the analyses, participants still rate some of the utilitarian levels significantly differently.

Table 6.25 The main effect of utilitarian

Utilitarian level	Mean	Std. error	95% confidence interval Lower bound	Upper bound
(1) High	18.021	.588	16.805	19.237
(2) Low	12.146	.629	10.844	13.448

Table 6.26 shows the pairwise comparisons for the main effect of utilitarian value levels (corrected using a Bonferroni adjustment to control the error rate). This table indicates that the significant main effect of the utilitarian levels reflects a significant difference ($p < .001$) between the high utilitarian and low utilitarian levels (i.e., level 1 *vs.* level 2). Moreover, the table shows a significant difference between the low utilitarian and high utilitarian levels (i.e., level 2 *vs.* level 1).

Table 6.26 The utilitarian levels pairwise comparisons

(I) Utilitarian	(J) Utilitarian	Mean difference (I-J)	Std. error	Sig.[a]	95% confidence interval for difference [a] Lower bound	Upper bound
1	2	5.875 *	.619	.000	4.594	7.156
2	1	-5.875 *	.619	.000	-7.156	-4.594

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

6.8.2.3 The Interaction Effects

Table 6.27 posits that the hedonic construct levels interacted in some way with the utilitarian construct levels. There is a significant interaction between the hedonic levels and the utilitarian levels $F(1, 23) = 36.074$, $p < .001$. This effect tells us that the levels of the hedonic construct had a different effect depending on which level of the utilitarian construct is presented alongside. To determine the nature of this interaction, we need to look at the mean squares (illustrated in Table 6.27) and the within-subjects contrasts interaction (illustrated in the plot graph Figure 6.7).

Table 6.27 Tests of within-subjects contrasts (hedonic and utilitarian values)

Source	Hedonic	Utilitarian	Type III sum of squares	df	Mean square	F	Sig.
Hedonic	Level 1 vs. Level 2		2562.667	1	2562.667	193.04	.000
Error(Hedonic)	Level 1 vs. Level 2		305.333	23	13.275		
Utilitarian		Level 1 vs. Level 2	828.375	1	828.375	90.030	.000
Error(Utilitarian)		Level 1 vs. Level 2	211.625	23	9.201		
Hedonic * Utilitarian	Level 1 vs. Level 2	Level 1 vs. Level 2	1568.167	1	1568.167	36.074	.000
Error(Hedonic *Utilitarian)	Level 1 vs. Level 2	Level 1 vs. Level 2	999.833	23	43.471		

Figure 6.7 3D sites utilitarian and hedonic values interaction graph.

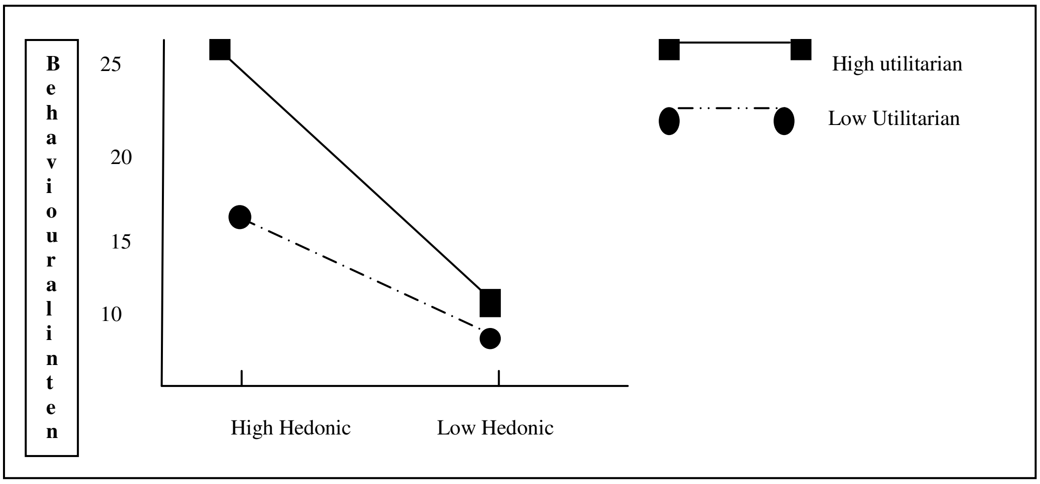


Figure 6.7 shows the interaction graph. Participants primed with the high utilitarian condition reported a higher behavioural intention when exposed to the high hedonic versus the low hedonic conditions ($M_{High\ hedonic} = 25.21$, $M_{low\ hedonic} = 10.8$, $F_{1,\ 23} = 36.05$, $p > .001$). However, participants primed with the low utilitarian condition reported a lower behavioural intention when exposed to the high hedonic versus the low hedonic conditions ($M_{High\ hedonic} = 15.3$, $M_{low\ hedonic} = 9$, $F_{1,\ 23} = 36.05$, $p > .001$).

Table 6.28 presents the paired comparisons table for the utilitarian levels on the hedonic levels. We are comparing the behavioural intention for the two utilitarian levels at each hedonic level provided by different 3D flashes. Under the first level of the utilitarian construct, the difference between the means of the two hedonic levels is 14.375. This difference is statistically significant. In other words, participants who have had high level of utilitarian and high level of hedonic values, while using the 3D flashes, achieved more behavioural intentions (14.375) when having high hedonic than low hedonic. Under the second level of the utilitarian, the difference between the means of the two hedonic levels is 6.292 points. This difference is statistically significant. In other words, participants who have had the low levels of utilitarian and hedonic values while using the 3D flashes achieved less behavioural intentions (-6.292). See Figure 6.8.

Table 6.28 Interaction simple effects (post ANOVA analysis) pairwise comparisons

Utilitarian level	(I) Hedonic	(J) Hedonic	Mean difference (I-J)	Std. error	Sig. [a]	95% confidence interval for difference [a]	
						Lower bound	Upper bound
1	1	2	14.375 *	.940	.000	12.431	16.319
	2	1	-14.375 *	.940	.000	-16.319	-12.431
2	1	2	6.292 *	1.062	.000	4.094	8.489
	2	1	-6.292 *	1.062	.000	-8.489	-4.094

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Table 6.29 presents the paired comparisons for hedonic values. This research is comparing the behavioural intention for the two levels of hedonic at each level of the utilitarian provided by different 3D flashes. Under the first level of the hedonic construct, the difference between the means of the two utilitarian levels is 9.917. This difference is statistically significant. In other words, participants who have had high levels of hedonic and utilitarian values while using the 3D flashes achieved more mean points (9.917) in the behavioural intention when having high hedonic rather than when having a low hedonic level. On the other hand, under the second level of the hedonic construct (the low hedonic); the difference between the means of the two levels of the utilitarian construct is 1.833 points. This difference is not statistically significant. See Figure 6.8.

Table 6.29 Interaction simple effects (post ANOVA analysis) pairwise comparisons

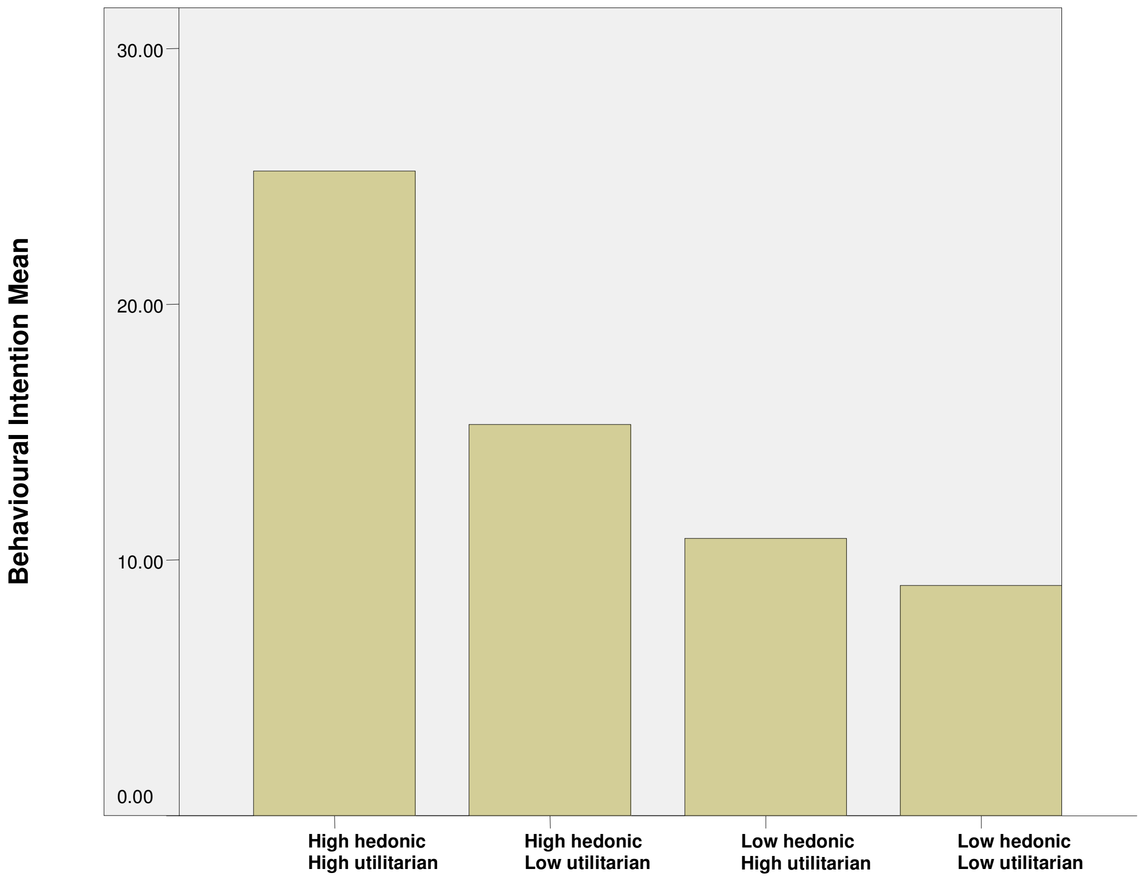
Hedonic levels	(I) utilitarian	(J) Utilitarian	Mean difference (I-J)	Std. error	Sig. [a]	95% confidence interval for difference [a] Lower bound	Upper bound
1	1	2	9.917 *	.876	.000	8.104	11.729
	2	1	-9.917 *	.876	.000	-11.729	-8.104
2	1	2	1.833	.951	.066	-.134	3.801
	2	1	-1.833	.951	.066	-3.801	.134

Based on estimated marginal means.

*. The mean difference is significant at the .05 level.

a. Adjustment for multiple comparisons: Bonferroni.

Figure 6.8 Mean of different levels of 3D utilitarian and hedonic values on behavioural intention mean



6.9 STAGE 5: ANALYSIS AND RESULTS OF STRUCTURAL EQUATION MODELLING (SEM)

Stage 5 aims to answer the sixth research question. This thesis used the SEM to test the proposed hypotheses between the latent constructs in the online S-O-R framework. Hair *et al*. (2006) recommends using two stages to test a proposed model using the SEM. First, testing the measurement model, which explains the relationships between the observed items and the latent (unobserved) construct. Moreover, this stage clearly illustrates the result of the confirmatory factor analysis. Second, testing the structural (i.e., regression path) model, which explains the causal relationships among the observed constructs. The following sections explain the analyses and the results of theses two models.

6.9.1 Measurement Model

The goodness of fit criteria and unidimensionality were used to evaluate the measurement model and its specification. On the one hand, unidimensionality was assessed by reliability tests (i.e., composite and Cronbach alpha reliabilities) and factor loadings for each construct alone. On the other hand, a variety of goodness-of-fit criteria has been chosen in this research since it is hard to depend on a single fit index to identify the correct model (Byrne, 2001). This thesis focuses on three types of goodness-of-fit criteria; absolute, incremental and parsimony fit indices. According to Hair *et al*. (2006. p, 706-708), absolute fit indices are used "to measure the overall goodness-of-fit for both the structural and measurement models collectively". However, the absolute fit indices evaluate the goodness-of-fit of a certain model independently from any other model. To that end, the incremental fit indices are used for "assessing how well a specified model fits relative to some alternative baseline model". Since the absolute fit indices do not compare the models to a specific null model (i.e. incremental fit indices), this research employs incremental fit indices besides absolute fit indices. Finally, whenever it is necessary, this thesis uses parsimony fit indices to decide which model is considered to be the best[6] (Hair *et al*., 2006). Table 6.30 summarises the main goodness-of-fit criteria that have been used in this research.

[6] For more information about fit indices see the Methodology Chapter.

Table 6.30 Goodness-of-fit criteria used in this research

Fit indices	Abbreviation	Type	Acceptance level in this research
Coefficient alpha	α	Unidimensionality	α > 0.7 adequate and > 0.5 is acceptable
Standardised Regression Weight	β		Beta > 0.15
Chi Square (with associated degrees of freedom and probability of significant different)	χ^2 (df, p)	Model fit	$p > 0.05$ (at α equals to 0.05 level)
Normed Chi-Square	χ^2/df	Absolute fit and model parsimony	$1.0 < \chi^2/df < 3.0$
Normalised Fit Index	NFI	Incremental fit Compare your model to baseline independence model	Values above 0.08 and close 0.90 indicate acceptable fit
Non-Normalised Fit Index	NNFI		
Comparative Fit Index	CFI		
Goodness Of Fit Index	GFI	Absolute fit	≥ 0.90
Adjusted Goodness of Fit	AGFI		≥ 0.90
Root Mean Square Residual	RMR		< 0.05
Root Mean Square Error of Approximation	RMSEA		< 0.08

Source: Developed from Hair *et al*. (2006)

The measurement models include twenty three indicators. Tables below (from 6.31 to 6.36) present the results of the measurement model, including the standardised factor loadings (λ), estimates, standard errors (S.E), critical ratios (C.R), squared multiple correlations, average variance extracted (AVE), composite and Cronbach alpha reliabilities for each construct. The tables reveal the following:

- The factor loadings of each construct indicators are significant. In other words, confirmatory factor analysis for each construct is significant and sufficient for doing the structural modelling. The standardised factor loadings (λ) have a value greater than .70, indicating a strong association between the factors and their construct. Though, only two indicators loaded below .70 (two items; control$_2$ and animated colours$_5$ loaded .61 and .61 respectively). This research kept them for further analysis since Churchill's (1979) recommends that factor loadings values above 0.5 are acceptable.

- Critical ratio (or t-values) is above 1.96 for the entire factor loadings, indicating that the factor loadings are statistically significant (Byrne, 2001; Hair *et al*. 2006).
- According to Fornell and Larker (1981, p. 45), average variance extracted (AVE) reveals information about "the amount of variance that is captured by the construct in relation to the amount of variance due to measurement error". Moreover, AVE represents a stronger indicator of the construct reliability than the composite reliability does (Fornell and Larker, 1981). The results show that the average variance extracted values of all the proposed model constructs ranged from .50 through .631, exceeding the threshold value of 0.50 or above that Fornell and Larker (1981) suggest.
- Composite reliabilities for the constructs ranged from .78 thorough .86, exceeding the threshold value of .70 that Hair *et al*. (2006) suggest.
- Cronbach alpha reliabilities for all constructs ranged from .747 thorough .877 exceeding the threshold value of .70 that Field (2005) suggest.

  Average variance extracted, composite and Cronbach alpha reliabilities present acceptable levels of reliability and validity (Fornell and Larker 1981; Hair *et al*., 2005).

Table 6.31 The Animated Colour Construct

Reliability Cronbach alpha = 0.747				Composite reliability = 0.7816				Squared multiple correlations	Average variance extracted
η1 Animated colours (ANIM) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.502
ANIM 3	<---	A. colours	.79	1.000				.631	
ANIM 4	<---	A. colours	.71	.764	.067	11.391	***	.499	
ANIM 5	<---	A. colours	.61	.643	.064	10.099	***	.375	

Table 6.32 The Control Construct

Reliability Cronbach alpha = 0.793				Composite reliability = 0.796				Squared multiple correlations	Average variance extracted
η2Control (CONT) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.50
CONT5	<---	Control	.78	1.000				.602	
CONT4	<---	Control	.71	.929	.077	12.097	***	.508	
CONT3	<---	Control	.71	.766	.076	10.009	***	.503	
CONT2	<---	Control	.61	.636	.071	8.916	***	.369	

Table 6.33 The Authenticity Construct

Reliability Cronbach alpha = 0.877				Composite reliability = 0.86				Squared multiple correlations	Average variance extracted
η3 3D Authenticity (AUTH) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.608
AUTH5	<---	Authenticity	.77	1.000				.598	
AUTH4	<---	Authenticity	.79	1.092	.078	14.093	***	.628	
AUTH3	<---	Authenticity	.81	1.144	.078	14.581	***	.656	
AUTH2	<---	Authenticity	.74	1.015	.076	13.293	***	.550	

Table 6.34 The Utilitarian Construct

Reliability Cronbach alpha = 0.855				Composite reliability = 0.85				Squared multiple correlations	Average variance extracted
η4 Utilitarian (UTIL) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.582
UTIL2	<---	Utilitarian	.80	1.000				.637	
UTIL 3	<---	Utilitarian	.92	1.271	.079	16.179	***	.844	
UTIL 4	<---	Utilitarian	.69	.832	.067	12.481	***	.475	
UTIL 5	<---	Utilitarian	.61	.752	.066	11.002	***	.375	

Table 6.35 The Hedonic Construct

Reliability Cronbach alpha = 0.858				Composite reliability = 0.86				Squared multiple correlations	Average variance extracted
η5 Hedonic (HED) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.585
HED5	<---	Hedonic	.64	1.000				.411	
HED4	<---	Hedonic	.77	1.343	.105	12.752	***	.589	
HED3	<---	Hedonic	.88	1.538	.128	11.987	***	.722	
HED2	<---	Hedonic	.79	1.598	.144	11.123	***	.618	

Table 6.36 The Behavioural Intention Construct

Reliability Cronbach alpha = 0.872				Composite reliability = 0.88				Squared multiple correlations	Average variance extracted
η6 Behavioural intention (BI) Standard factor loading (λ)				Estimate	S.E.	C.R.	P	Value	.631
BI2	<---	Behavioural intention	.81	1.000				.662	
BI3	<---	Behavioural intention	.82	.982	.061	16.151	***	.673	
BI4	<---	Behavioural intention	.82	1.156	.075	15.323	***	.678	
BI5	<---	Behavioural intention	.72	.776	.059	13.160	***	.525	

6.9.2 Reliability and Validity of Constructs

Hair *et al*. (2006) and Fornell and Larckers (1981) posit that assessing construct validity is a product of two validities; convergent and discriminant validities. The following explains each type.

A) Convergent Validity

Convergent validity related to the internal consistent validity between each construct items, i.e., high or low correlations (Fornell and Larckers, 1981). Convergent validity was assessed based on the indicators estimated coefficients of each measurement scale used in this research (composite reliability), average variance extracted and Cronbach alpha. Tables 6.31 to 6.36 show that the composite reliability for all constructs is above 0.78, average variance extracted is equal or above 0.5, and Cronbach alpha is above 0.7. All are good indicators of the convergent validity (Fornell and Larckers, 1981).

B) Discriminant Validity

Discriminant validity was conducted to make sure that each construct and its indicators, in the proposed model, differ from any other construct and its indicators. Table 6.37 shows discriminant validity of all constructs used in the online S-O-R model. Furthermore, the diagonal line shows the squared roots of average variance extracted (SRAVE) for each construct, which is higher than any correlation value below it, indicating an acceptable level of discriminant validity (Fornell and Larckers, 1981).

Table 6.37 Discriminant validity

Construct	Animated colours	Control	3D authenticity	Utilitarian	Hedonic	Behavioural intention
Animated colours	**.708**					
Control	.469(**)	**.707**				
3D authenticity	.633(**)	.469(**)	**.774**			
Utilitarian	.397(**)	.360(**)	.449(**)	**.754**		
Hedonic	.464(**)	.329(**)	.586(**)	.463(**)	**0.761**	
Behavioural intention	.296(**)	.228(**)	.427(**)	.392(**)	.403(**)	**.8**

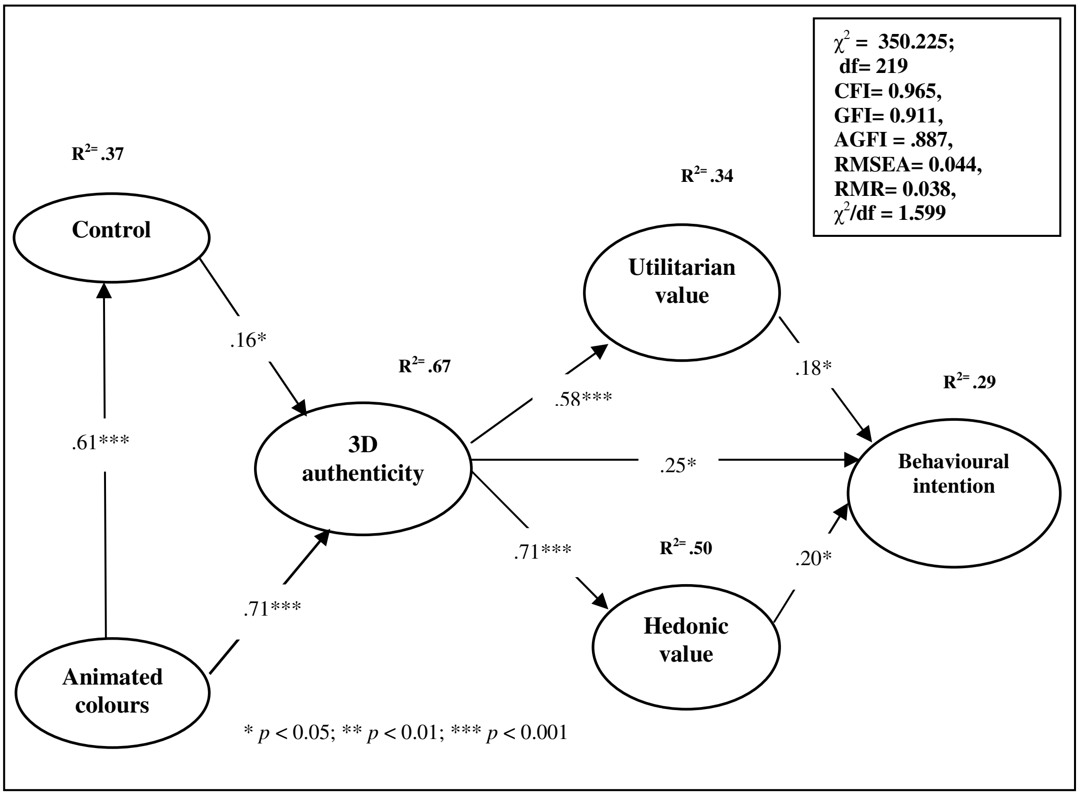
(**) all correlations significant at $p < 0.01$ except where noted. Diagonal elements are square roots of average variance extracted.

6.9.3 Structural Model: Hypotheses Testing

The online S-O-R model results are explained in Figure 6.9. The results of the proposed conceptual model reveal a chi-square of 350.225 (degrees of freedom**,** df = 219; $p < .001$), goodness-of-fit index (GFI) of .911, adjusted goodness-of-fit index (AGFI) of .887, comparative fit index (CFI) of .965, normed fit index (NFI) of .912, relative fit index (RFI) of .9, incremental fit index (IFI) of .965, and χ^2/df **=** 1.599. All the indexes indicate a good model fit (e.g., GFI, NFI, RFI, CFI, and IFI should be equal or greater than 0.9, according to Byrne, 2001; Hair *et al*. 2006). The root mean square error of approximation (RMSEA) reveals a value of .044 (an acceptable level should be below .08, according to Hair *et al*., 2006); all the fit indices in this thesis are within the acceptable limits (Byrne, 2001; Hair *et al*. 2006; Tabachnick and Fidell, 2007).

Figure 6.9 presents the final model with structural path coefficients and coefficient of determination (R^2). All the hypotheses of the conceptual model were statistically supported (p < .05). Moreover, Table 6.38 shows that the animated colours construct exhibited a significant positive effect on the control construct (H_{6c}: t = 7.888). Furthermore, the animated colours and control constructs had significant positive effects on the 3D authenticity construct (H_{6b}: t = 7.951; H_{6a}: t = 2.098). The 3D authenticity construct revealed significant positive effects on utilitarian and hedonic values (H_{6d}: t = 8.875; H_{6e}: t = 8.567). Finally, as this thesis hypothesised, 3D authenticity, utilitarian and hedonic values have positive effect on behavioural intention (H_{6f}: t = 2.465, H_{6g}: t = 2.454, H_{6h}: t = 2.216).

Figure 6.9 The results of the structural model, the standardised path coefficient between constructs and R^2



Source: Developed for this research.

Table 6.38 Hypotheses testing

Standardised regression paths (β)		Estimate	S.E	C.R	P	Hypothesis
H_{6a}	Control → 3D Authenticity	.165	.079	2.098	.036	Supported
H_{6b}	Animated colours → 3D authenticity	.672	.085	7.951	***	Supported
H_{6c}	Animated colours → Control	.539	.068	7.888	***	Supported
H_{6d}	3D authenticity → Utilitarian value	.470	.055	8.567	***	Supported
H_{6e}	3D authenticity → Hedonic value	.483	.054	8.875	***	Supported
H_{6f}	3D authenticity → Behavioural intention	.229	.093	2.465	.014	Supported
H_{6g}	Utilitarian value → Behavioural intention	.211	.086	2.454	.014	Supported
H_{6h}	Hedonic value → Behavioural intention	.274	.124	2.216	.027	Supported

*** $p < 0.001$

Behavioural intention was predicted by the 3D authenticity constructs (standardised path coefficient, $\beta = .25$, $p < .05$), utilitarian value ($\beta = .18$, $p < .05$) and hedonic value ($\beta = 0.20$, $p < .05$) and these constructs together explained 29% of the behavioural intention (coefficient of determination, $R^2 = 0.29$). As a result, hypotheses H_{6f}, H_{6g} and H_{6h} were supported. The 3D authenticity construct was predicted by control ($\beta = 0.16$, $p < .05$) and animated colour constructs ($\beta = 0.71$, $p < .001$). These constructs explained 67% of the 3D authenticity construct ($R^2 = 0.67$). As a result, hypotheses H_{6a} and H_{6b} were supported. Finally, the utilitarian ($\beta = 0.58$, $p < .001$) and hedonic values ($\beta = .71$, $p < .001$) were predicted by the 3D authenticity construct, 34% of the utilitarian values explained by the 3D authenticity construct and 50% of the hedonic values explained by the 3D authenticity construct. As a result, hypotheses H_{6d} and H_{6e} were supported.

6.9.4 Decomposition of Effects

Decomposition of effects analysis was conducted to assess the indirect effects of the predictor constructs on participants' behavioural intention. Table 6.39 reports the direct, indirect, and total effects of the predictor variables (i.e., animated colour, control, 3D authenticity, hedonic and utilitarian value) on behavioural intention. The animated colour had significant indirect effects on behavioural intention, suggesting mediating effects of the 3D authenticity, utilitarian and hedonic constructs. The proposed conceptual model explained a moderate amount of the variance in behavioural intention ($R^2 = .29$). For behavioural intention, 3D authenticity had the strongest direct effect (.246), followed by hedonic value (.202). Animated colours had the strongest indirect effect (.399), followed by 3D authenticity (.249). The 3D authenticity construct had the strongest total effect on behavioural intention (.495), followed by animated colours (.399). Finally, control had the weakest total effect on behavioural intention (.077). The hedonic, utilitarian and 3D authenticity constructs are full mediation between control, animated colours and behavioural intention (i.e. no new paths indicated by modification indices and other direct paths are non-significant).

Table 6.39 The standardised indirect, direct and total effects-estimates

Predictor variables	Behavioural intention toward the online retailer		
	Indirect effects	Direct effects	Total effects
Animated colours	.399	------	.399
Control	.077	------	.077
3D authenticity	.249	.246	.495
Utilitarian value	------	.182	.182
Hedonic value	------	.202	.202
R^2			.29

6.10 INVARIANCE (MULTI-GROUP) ANALYSIS

Invariance analyses have been used in this thesis to determine the effects of gender, e-shopping experience, age, educational levels and the study backgrounds on the S-O-R framework constructs and their relationships. Figure 6.10 explains the steps used in the invariance analyses.

First, this thesis starts with conducting a measurement invariance analysis (measurement weight) for gender, e-shopping experience, age, education levels, and study backgrounds to determine whether, for example, the males and females groups would use the same pattern in measuring the observed items. If the result is invariant, then the data of each group is suitable for further analysis (i.e., structural invariance analysis). However, if the two groups understood the items differently (non-invariance), then this thesis identifies the source of the non-invariance. To do so, this thesis identifies the observed item(s) that caused the non-invariance. If the result of the measurement model is invariance, then this thesis goes to the next step. However, if the results still non-invariant, then this thesis stops the analysis.

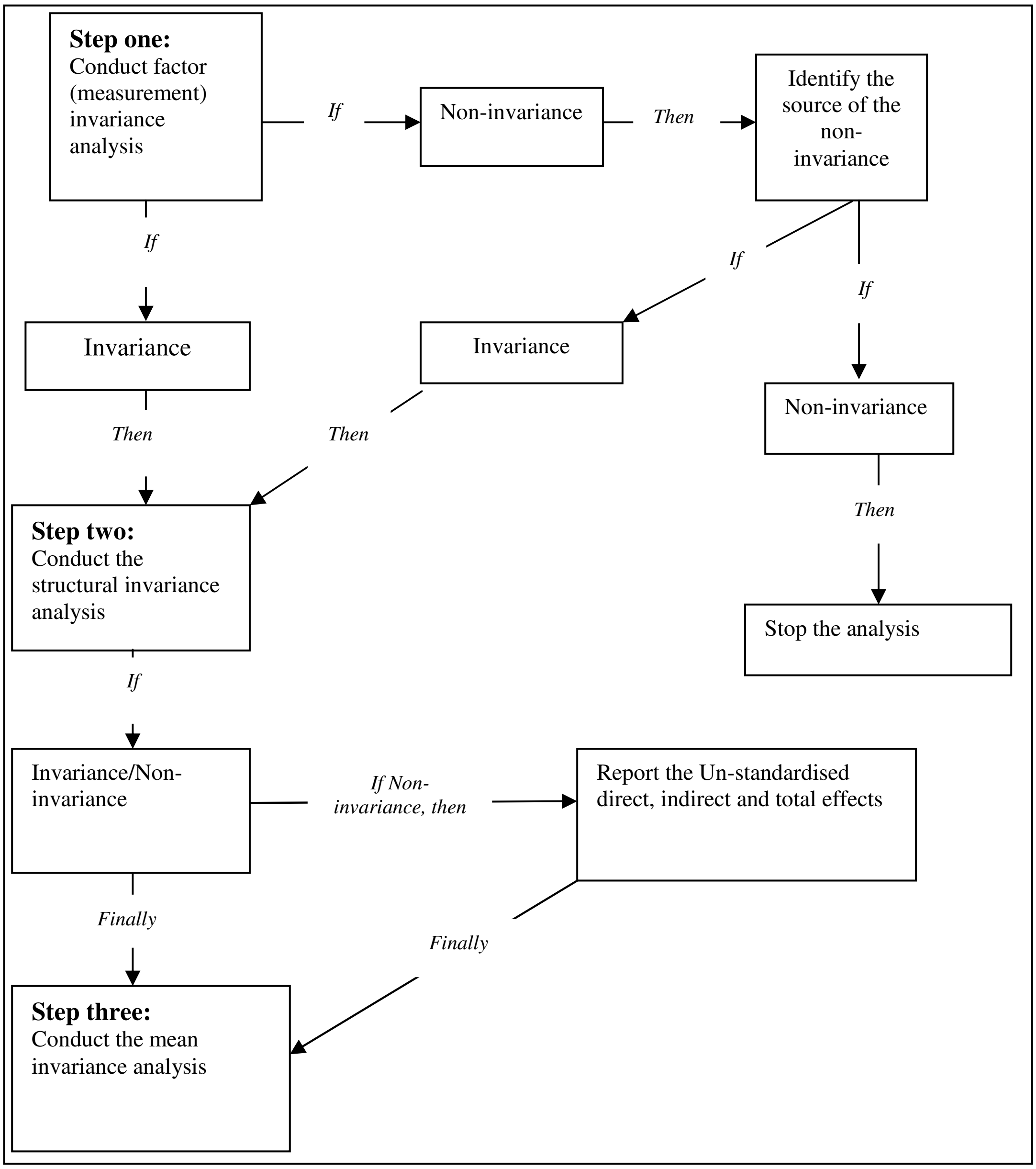
Second, after having the insignificant results in the measurement model, this thesis conducts the invariance structural model analysis to determine if gender, e-shopping experience, age, education levels and study background groups have invariance or non-invariance results in perceiving the relationships between the unobserved constructs. In conducting this analysis, this research follows two steps:

(i) If the members of any group (e.g., the males and females groups) perceive the relationships between the constructs similarly (i.e., invariance), then, this research moves to the third step (i.e., latent mean invariance analysis)

(ii) However, if the members of any group perceive the relationships between the constructs differently (i.e., non-invariance), then this thesis determines the source of the non-invariance. Moreover, this thesis reports the un-standardised direct, indirect and total effects if the structural model analyses are non-invariance.

Third, this thesis conducts the latent mean invariance analyses among the latent constructs to determine if the groups have perceived each construct similarly (invariance) or differently (non-invariance). In all the three previous steps, this thesis reports $\Delta\chi^2$ and Δdf and fit indices (TLI, CFI and RMSEA) models for the comparison purposes.

Figure 6.10 Invariance analysis steps



Source: Developed for this research

6.10.1 Gender

The first invariance analyses classify the participants into two groups according to the participants' gender (i.e., males or females). The following explains gender invariance results.

First, the measurement model results (Table 6.40) reveal insignificant differences between the male and female groups in understanding the questions of each latent construct. In other words, both groups have understood the questions similarly.

Table 6.40 Results of factorial invariance analysis for gender (assuming model unconstrained to be correct)

Gender (n= 312) Measurement model	P	χ^2	df	$\Delta\chi^2$	Δdf	CFI	RMSEA
	.404	635.786	455	17.761	17	.952	0.036

Second, the structural model results (Table 6.41) reveal insignificant differences between the male and female groups in determining the relationships between the proposed constructs. In other words, both groups have perceived the importance of the relationships between the constructs similarly.

Table 6.41 Results of structural invariance analysis (assuming model measurement weight to be correct)

Gender (n = 312) Structural model	P	χ^2	df	$\Delta\chi^2$	Δdf	CFI	RMSEA
	.082	649.793	463	14.007	8	.952	0.036

Third, the latent mean model results (Tables 6.42 and 6.43) reveal that the behavioural intention construct has a non-invariance difference between the male and female groups. The female group is higher (.179) than the male group in perceiving the behavioural intention construct.

Table 6.42 Mean: (male - unconstrained) (assuming model measurement weight to be correct)

Gender (n = 312) Structural mean model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.019	650.619	464	15.136	6	.946	.950	0.036

Table 6.43 Means: (male - measurement weight)

Construct (gender mean 312)	Estimate	S.E	C.R	P
Control	-.138	.088	-1.562	.118
Animated colours	.069	.069	.994	.320
3D authenticity	.016	.097	.168	.867
Hedonic	.071	.065	1.092	.275
Utilitarian	.048	.055	.875	.382
Behavioural intention	.179	.069	2.581	**.010**

6.10.2 E-shopping Experience

The second invariance analyses classify the participants into two groups according to their e-shopping experiences (i.e., more experienced or less experienced). The following explains the e-shopping experience invariance results.

First, the measurement model results (Table 6.44) reveal invariance (insignificant) differences between those who are more experienced in buying products online and those who are less experienced in understanding the questions of each latent construct similarly. In other words, both groups have perceived the questions similarly.

Table 6.44 Results of factorial invariance analysis for e-shopping (assuming model unconstrained to be correct)

e-shopping (n = 312) Measurement model	P	χ^2	df	$\Delta \chi^2$	Δdf	TLI	CFI	RMSEA
	.897	632.059	455	10.158	17	.948	.953	0.035

Second, the structural model results (Table 6.45) reveal invariance (insignificant) differences between the more experienced and the less experienced groups in determining the relationships between the proposed constructs. In other words, both groups have perceived the importance of the relationships among the constructs similarly.

Table 6.45 Results of structural invariance analysis (assuming model measurement weight to be correct)

E-shopping (n = 312) Structural model	P	χ^2	df	$\Delta \chi^2$	Δdf	TLI	CFI	RMSEA
	.946	634.858	463	2.799	8	.950	.954	0.035

Third, the latent mean model results (Tables 6.46 and 6.47) reveal invariance differences between the more experienced and the less experienced groups. In other words, both groups perceived the latent constructs similarly.

Table 6.46 Mean (more experience - unconstrained) (assuming model measurement weight to be correct)

e-shopping (n = 312) Structural mean model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.323	634.783	464	6.979	6	.951	.955	.034

Table 6.47 Means (more experience – measurement weight)

Construct (e-shopping mean 312)	Estimate	S.E	C.R	P
Control	-.008	.100	-.079	**.937**
Animated colours	.119	.072	1.661	**.097**
3D Authenticity	.155	.099	1.564	**.118**
Hedonic	.108	.067	1.618	**.106**
Utilitarian	-.007	.058	-.119	**.905**
Behavioural intention	.069	.068	1.018	**.308**

6.10.3 Age

The third invariance analyses classify the participants into two groups according to the participants' ages (i.e., 20 years or less and above 20 years). The following explains age invariance results.

First, the measurement model results (Table 6.50) reveal invariance differences between the 20 years old or less and the more than 20 years old groups in understanding the latent construct questions. In other words, both groups have understood the questions similarly.

Table 6.48 Results of factorial invariance analysis for age (assuming model unconstrained to be correct)

Age (n= 312) Measurement model	P	χ^2	df	$\Delta\chi^2$	Δdf	CFI	RMSEA
	.516	674.264	455	16.111	17	.942	.039

Second, the structural model results (Table 6.49) reveals invariance differences between the 20 years old or less group and the more than 20 years old group in determining the relationships between the proposed constructs. In other words, both groups perceived the importance of the relationships among the constructs similarly.

Table 6.49 Results of structural invariance analysis (assuming model measurement weight to be correct)

Age (n = 312) Structural model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.946	677.074	463	2.811	8	.938	.944	.039

Third, the latent mean model results (Tables 6.50) reveal that the control construct has non-invariance differences between the 20 years old or less group and the more than 20 years old group, even though the structural mean model (Table 6.50) reveals insignificant differences between the two groups. This thesis finds out, after checking the mean table (Table 6.51), that the control construct mean has a significant difference between the two groups. This means that the group of more than 20 years old is lower (-.221) than the group of 20 years old or less in perceiving the control construct.

Table 6.50 Mean (more than 20 years - unconstrained) (assuming model measurement weight to be correct)

Age (n = 312) Structural mean model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.379	676.612	646	6.404	6	.939	.944	.038

Table 6.51 Mean (more than 20 – measurement weight)

Construct (age mean 312)	Estimate	S.E	C.R	P
Control	-.221	.091	-2.309	**.012**
Animated colours	-.024	.070	-.347	.729
3D authenticity	-.050	.098	-.514	.607
Hedonic	-.051	.065	-.789	.430
Utilitarian	-.054	.054	-.996	.319
Behavioural intention	-.015	.068	-.213	.831

6.10.4 Education Level

The fourth invariance analyses classify the participants into two groups according to the participants' educational levels (undergraduates and postgraduates groups). The following explains the educational level invariance results. First, the measurement model results (Table 6.52) reveal invariance differences between the undergraduates and postgraduates groups in understanding the questions of each latent construct.

Table 6.52 Results of factorial invariance analysis for education (assuming model unconstrained to be correct)

Education level (n = 312) Measurement model	P	χ^2	df	$\Delta\chi^2$	Δdf	CFI	RMSEA
	.562	649.828	455	15.466	17	.949	0.37

Second, the structural model results (Table 6.53) reveal invariance differences between the undergraduates and the postgraduates groups in determining the relationships between the proposed constructs.

Table 6.53 Results of structural invariance analysis (assuming model measurement weight to be correct)

Education level (n = 312) Structural model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.240	660.190	463	10.363	8	.943	.948	.037

Third, the latent mean model results (Tables 6.54 and 6.55) reveal invariance differences between the undergraduates and the postgraduates groups. In other words, both groups perceived the latent constructs similarly.

Table 6.54 Mean (undergraduate - unconstrained) (assuming model measurement weight to be correct)

education level (n = 312) Structural mean model	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
	.072	656.679	464	11.575	6	.945	.949	0.037

Table 6.55 Mean (undergraduate – measurement weight)

Construct (education level mean 312)	Estimate	S.E	C.R	P
Control	.178	.091	1.957	**.050**
3D animated colours	.125	.071	1.775	**.076**
Authenticity	.001	.096	.010	**.992**
Hedonic	-.029	.066	-.447	**.655**
Utilitarian	.016	.056	.291	**.771**
Behavioural intention	.080	.069	1.167	**.243**

6.10.5 Participants' Study Backgrounds

The fifth invariance analyses classify the participants into two groups according to the participants' study backgrounds (Business-Social and Maths-IT-Engineering groups). This classification come about after Maths, IT and Engineering students are expected to be more familiar with the 3D product visualisation as a technology and they are more quantitative approach. In other words, choosing such a group was mainly for the purpose of criticizing the novelty of the 3D flashes. Whereas choosing the Business and Social students as a second group came about for criticizing the amount of enjoyment and behavioural intention (being more qualitative approach) when interacting with the 3D product visualisation. The following explains participants' study backgrounds invariance results.

First, the measurement model results (Table 6.56) reveal insignificant differences between Business-Social studies and the Maths-IT-Engineering studies backgrounds in understanding the questions. In other words, both groups have perceived the questions similarly.

Table 6.56 Results of factorial invariance analysis for background (assuming model unconstrained to be correct)

Background	P	χ^2	df	$\Delta \chi^2$	Δdf	CFI	RMSEA
(n= 312) Measurement model	**.221**	675.953	455	21.115	17	.943	0.040

Second, structural model results (Table 6.57) reveal non-invariance (significant) differences between the Business-Social studies and the Maths-IT-Engineering studies groups in determining the relationships between the proposed constructs. The structural model results (Table 6.58) reveal significant differences between the Business-Social studies and the Maths-IT-Engineering studies groups. The relationships between 3D authenticity → hedonic, and hedonic → behavioural intention are the source of this non-invariance. In other words, both groups perceived the importance of the hedonic values differently. Study background moderates the influence of 3D authenticity on hedonic and the effect of hedonic on behavioural intention.

Table 6.57 Results of structural invariance analysis (assuming model measurement weight to be correct)

Background (n = 312) Structural model	P	χ^2	df	$\Delta \chi^2$	Δdf	TLI	CFI	RMSEA
	.010	696.033	463	20.080	8	.934	.939	0.040

Table 6.58 Results of path coefficient invariance analysis for study background

Model	P	χ^2	df	$\Delta \chi^2$	Δdf	TLI	CFI	RAMSE
Animated colours→ 3D Authenticity	.221	654.963	439	.125	1	.935	.944	.040
Control → 3D Authenticity	.589	655.131	439	.292	1	.935	.944	.040
3D Authenticity → Hedonic	.002**	664.788	439	9.950	1	.932	.941	.041
3D Authenticity → Utilitarian	.128	657.156	439	2.317	1	.935	.943	.040
Utilitarian → BI	.295	655.934	439	1.096	1	.935	.944	.040
Hedonic → BI	.048*	658.745	439	3.906	1	.934	.943	.040
Animated colours → Control	.326	655.804	439	.966	1	.935	.944	.040
3D Authenticity → BI	.419	655.493	441	.654	1	.935	.944	.040

** $p < 0.05$; ** $p < 0.01$.*

Table 6.59 shows the results of un-standardised total effects- estimates for the Maths-IT-Engineering studies background group and the Business-Social studies background group. The Maths-IT-Engineering group perceives the total effects of the 3D authenticity construct on hedonic value more (.680) than the Business-Social studies group (.333). Moreover, they perceived the total effects of hedonic construct on the behavioural intention (.524) more than the Business-Social studies group (.029).

Table 6.59.: AMOS selected output: total effect for study background

Construct	**Business-Social group**					**Maths-IT-Engineering**				
	Colour	control	3D Auth	Utilitarian	Hedonic	colour	control	3D Auth	Utilitarian	Hedonic
control	.559	000	000	000	000	.431	000	000	000	000
3D Auth	.722	.099	000	000	000	.814	.196	000	000	000
Utilitarian	.280	.039	.388	000	000	.452	.109	.555	000	000
Hedonic	.240	.033	.333*	000	000	.553	.133	.680*	000	000
Behavioural intention	.221	.030	.306	.169	.029*	.503	.121	.618	.349	.524*

* Significant $p < .05$.

Third, the latent mean model results (Tables 6.60 and 6.61) reveal invariance differences between the Business-Social studies and the Maths-IT-Engineering studies, both groups perceived the latent constructs similarly.

Table 6.60 Mean (human studies - unconstrained) (assuming model measurement weight to be correct)

Background	P	χ^2	df	$\Delta\chi^2$	Δdf	TLI	CFI	RMSEA
(n= 312) Structural mean model	**.664**	681.002	464	4.094	6	.938	.944	0.039

Table 6.61 Mean (Business-Social studies - measurement weight)

Construct (Background mean 312)	Estimate	S.E	C.R	P
Control	.080	.092	.873	**.382**
Animated colours	.036	.068	.530	**.596**
Authenticity	.084	.097	.871	**.384**
Hedonic	.045	.065	.698	**.485**
Utilitarian	0.068	.056	1.214	**.225**
Behavioural intention	.127	.068	1.873	**.061**

6.11 SUMMARY

This chapter reported the data analysis of this study. First, data preparation and scanning were used to ensure that the data are normally distributed. Second, a series of one-way repeated measure ANOVAs was used to examine three issues: how do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites? How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailers' websites? How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailers' websites? Third, a series of two-way repeated measures ANOVAs was used to determine the effects of the progressive conditions on users' dependent variables. Fourth, using the analysis of moment structures (AMOS), this research evaluated the measurement model and structural model of the proposed online S-O-R model. Finally, this thesis conducted invariance analyses to determine how different groups (e.g., age, gender, e-shopping experience) perceive the model's items, paths and means. Overall, the proposed hypotheses were confirmed using ANOVA and SEM (measurement, structural and latent mean invariance analysis). Discussion, conclusions and implications of the results will be found in the next chapter.

7 CHAPTER SEVEN: DISCUSSION AND CONCLUSIONS

7.1 INTRODUCTION

Previously in Chapter Six, this thesis has examined and reported the results of the proposed hypotheses. This chapter aims to interpret the demonstrated results and to fulfil the objectives of this research by answering the research questions and testing the relationships in the proposed conceptual framework. The research questions (RQs) of this study have been illustrated in Chapter 1. These are:

(RQ1) How do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?

(RQ2) How do consumers perceive 3D product visualisation hedonic values compared with 2D hedonic values on online retailers' website?

(RQ3) How do consumers perceive 3D utilitarian values compared with 2D utilitarian values on online retailers' website?

(RQ4) How do different levels of 3D control and animated colours influence 3D authenticity?

(RQ5) How do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?

(RQ6) How do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?

This chapter is organised as follows: Section 7.2 explains the main limitations of this study. Section 7.3 discusses the results of the research questions and the proposed hypotheses. Section 7.4 describes the differences and generalisability across shopper groups. Theoretical, managerial and methodological implications and contributions are drawn in Section 7.5. Section 7.6 describes future research directions. Section 7.7 highlights the closing remarks which are drawn from the discussion chapter. Section 7.8 summarises the thesis conclusions, and Section 7.9 summarises the main contributions.

7.2 RESEARCH LIMITATIONS

The following represents the main limitations in this thesis. First, the generalisability of the results is limited by the student sample, and cannot be applied to all online consumer groups. However, this thesis argues that students represent the shoppers of tomorrow (Balabanis and Reynolds, 2001) and the research, thus, has prescient value. Moreover, the generalisability of this research results might be limited due to using an experimental approach design, which might restrict the external validity, because the main goal of an experiment is theory testing rather than generalising the results to a population (Li *et al*., 2002).

Second, since this study has focused only on 3D online laptops, which are considered to be products that are associated with more search or experience, and used the progressive levels to control any potential bias, it is unclear to what extent the results can be generalised and applied to other online products, such as the clothing sector.

Third, only behavioural intention was used in the online S-O-R model as the main dependent variable due to the fictitious sites that have been designed for the purposes of this study. Notwithstanding, using behavioural intention has been supported by previous researchers (e.g., Gregory *et al*., 1982) and it has been shown to be a strong indicator for predicting consumers' actual behaviour.

Fourth, this research has investigated the effect of visual stimulus without testing the effect of the auditory stimulus (i.e., real sounds of the laptop). As a result, it is not clear how auditory and visual stimuli (collectively) may influence the 3D authenticity construct. However, Pimentel and Teixeira (1994, p. 164) find that visual stimuli are the main sensory cues in producing the virtual experience.

Fifth, to conduct these research experiments, the researcher has used Brunel University Internet access. In other words, the participants have not felt any delay in internet access or in computers performance. As a result, the findings might not be applied to other households' broadband internet connections.
Finally, the cosmopolitan nature of Brunel University and the students' different cultural backgrounds might affect the accuracy of the results. The demographics analysis shows eight countries (that best describe participants' cultures) participated in this study outcome.

7.3 RESEARCH QUESTIONS

7.3.1 RQ1: 3D Telepresence Vs 3D Authenticity

Stage 1 results highlight the importance of the authenticity construct for 3D product visualisation. Our 3D authenticity scale is suitable and convenient for academics and practitioners interested in using 3D visualisation to simulate real products in the online retail context. This thesis clarifies the main differences between 3D authenticity and telepresence; telepresence involves illusion or a sense of being transported to another place, whereas authenticity refers to the ability to imagine a virtual object as real.

This research's results support the previous theoretical work of Lee (2004) which reviewed previous definitions of telepresence and presence and argued that none of them could be used to tap the concept of using a virtual environment to reflect the consumer virtual experience. Lee proposed using "para-authentic objects" to simulate virtual versions of real life objects. The results of this thesis provide empirical support for that proposition. Furthermore, the 3D authenticity construct reflects the notion of realism in the 3D area, which Klein (2003) advises marketers to apply in order to positively influence product beliefs.

The telepresence theory (originally) has been evolved and established in the immersive virtual reality environment. Marketers within the context of the online retailer have then applied this theory into a non-immersive virtual reality environment and used a scale that has been established to measure a TV telepresence rather than a real product. Such a scale might confuse e-marketers who are interested in measuring product presence for the online retailer. Overall, this research finds that using the authenticity theory within the online retail context is better than using the telepresence theory to measure consumers' virtual experience.

As an aside to the above result, telepresence theory should not be rejected in the e-retail context. Telepresence theory is a valid and an acceptable theory if marketers employ any external interfaces, such as goggles, head-mounted visors, data-gloves, joysticks, head trackers and televisions, to measure how consumers, for example, perceive places (i.e., within the immersive VR). This stage answered the first research question, that participants perceived 3D product visualisation as real, authentic but not as a state of being transported into another area, and it supported H_1.

7.3.2 RQ2: 3D Hedonic Vs 2D Hedonic Value

The results of Stage 2 reveal a significant difference between the hedonic values extracted from 3D product visualisation and 2D static pictures. This stage answered the second research question and explained that participants perceived 3D product visualisations as more hedonic and enjoyable than 2D product visualisations. The results of this stage supported H_2 regarding the ability of the 3D visualisation to generate more hedonic values than 2D static pictures. This result supports Kim and Forsythe's (2007) study which finds 3D product visualisation as a richer source of entertainment and fun in comparison to 2D static pictures. Moreover, this result comes in accordance with previous research on the 3D virtual models, for example, Fiore *et al.* (2005a) emphasise the importance of a high level of 3D product visualisation as a rich source for the experiential value. Fiore *et al.* (2005b) find that a high level of 3D product visualisation is a prosperous source of pleasure. In addition, Kim *et al.* (2007) posit that a high level of 3D product visualisation enhances consumers' enjoyment. Kim and Forsythe's (2008) empirical result reveals that a 3D virtual model produces more hedonic values than a 2D static site. Fasolo *et al.'s* (2006) empirical results reveal that consumers' attention is accentuated towards the online retailer, which has 3D animation products instead of 2D static pictures. Moreover, Fasolo *et al.* (2006) assert that a 3D animation increases customers' preferences.

7.3.3 RQ3: 3D Utilitarian Vs 2D Utilitarian Value

Stage 2 reveals insignificant differences between the high levels of utilitarian values when using either 2D or 3D sites. This stage answered the third research question and supported H_3 regarding the ability of the 3D and 2D product visualisations to provide similar utilitarian value once the highest levels of information in both sites are included. This result asserts the importance of a well designed 3D site to reflect the essential actual knowledge which consumers are seeking. This study finds a 3D site, which has more information about a laptop, helps consumers to make their decisions directly and easily. This result, also, supports previous research findings (e.g., Kim and Biocca; 1997; Li *et al.*, 2003; and Suh and Lee, 2005), which report the importance of 3D product visualisations in enhancing consumer learning. For example, Kim and Forsythe's (2008) empirical result reveals that a 3D rotation view has two roles: functional, and hedonic with slightly higher functional role. The authors state that, as with 3D, 2D has a more functional than hedonic role. Jiang and Benbasat (2007. p, 478) posit that the 2D static picture and 3D product visualisation presentation forms provide the same knowledge (i.e., the extent to which consumers actually understand product information) when a consumer seeks utilitarian information about a high task complexity product (such as a laptop).

Unlike Suh and Lee's (2005) study, this research finds an insignificant difference between the high levels of 3D product visualisations and 2D static pictures in enhancing the utilitarian values. The main reason behind this result is the manner of designing and testing the utilitarian values in this study. Though Suh and Lee's (2005) study uses two interface designs (i.e., 2D and 3D) and measures their abilities to enhance consumer learning, based on the assumption of product trial, they emphasise the ability of 3D visualisation to enhance consumers' perceived and actual knowledge over the 2D static pictures which usually do not enable users to try the product virtually.

Suh and Lee's (2005) empirical research reveals that product types play an important role in enhancing participants' cognitive process. The authors find that using a 3D stimulus (such as 3D table; virtual high experiential product) provides consumers with greater perceived product knowledge than a 3D desktop computer (virtual low experiential product). On the other hand, Suh and Lee's (2005) results show insignificant differences between the effects of 3D product and 2D static picture (if both presented the actual product knowledge) on purchase intention if only virtual low experiential product is used (i.e., the case of 3D desktop computer).

Suh and Lee's (2005) manipulation of the 3D visual information focused on the addition of the sensory information that a consumer can see and feel when navigating 3D sites. On the other hand, 2D sites were illustrated on static figures, of the proposed products without participants' ability to enlarge them. The above design has enabled users to have more sensory information about the 3D products in comparison to the 2D products. Moreover, Suh and Lee's (2005) study did not carry out any manipulation check to pre-test the differences between high levels and low levels of 3D and 2D interfaces in simulating the actual product knowledge as this study did. This thesis carried out manipulation checks to determine if participants have noticed the differences between the high and low levels of each interface, and then tested the differences between the high levels of utilitarian values that 3D and 2D interfaces produced to participants. In doing so, this thesis designed two sites to test how participants perceived the utilitarian aspects when a high level of information is available. This study included sensory (perceived) and actual information about the laptops in the design of the 3D flashes. On the other hand, this study designed static picture (2D) sites which provided similar information to that provided by the 3D sites but with less sensory richness (i.e., consumers can enlarge the static picture of a laptop). The main goal from carrying out this stage was to measure the level of the information that both sites provide to participants (i.e., sensory and actual) and how participants will eventually evaluate utilitarian values of each site.

7.3.4 RQ4: The Control and Animated Colour Constructs

Stage 3 results of the progressive levels of control and animated colour constructs point out that the high levels of control and animated colour lead to a high level of 3D authenticity. This result asserts that high levels of control and animated colour constructs produce a higher level of 3D authenticity. Moreover, this finding reveals that if marketers want to create a virtual experience that is very similar to the direct experience, then they should increase the levels of control and animated colours in 3D flashes. The results of this stage answered the fourth research question and support H_4 regarding the effect of the high levels of control and animated colours on 3D authenticity.

Consumers' ability to zoom in or out, rotate and change the laptop colours enhances their feelings of seeing and interacting with a real authentic object. 3D product visualisation, as an example of a rich media, allows customers to control the content of the 3D flash and to witness the animated colours as if they were in an offline retailer. These results come in line with previous studies (e.g., Coyle and Thorson, 2001; Klein, 2003) which have empirically tested the effects of the progressive levels of user control and media richness on 3D realism or telepresence, and found that the high levels of control and media richness often produced a high level of 3D realism or telepresence. Notwithstanding, since this research is replacing the notion of 3D telepresence (which indicates an illusion or transportation state) with the notion of 3D authenticity. The antecedents of 3D authenticity (i.e., control and animated colour) seem similar to those of the telepresence construct. However, when investigating the antecedents of 3D authenticity, researchers should focus on certain real elements of interactivity and vividness rather than on the abstract constructs. The control and animated colours constructs have positive and significant effects on 3D authenticity construct (Control $_{high}$ = 17, versus Control $_{low}$ = 11.7, $F_{1, 23} = 60.778$, $p < .001$; Animated colours $_{high}$ = 16.417, versus Animated colours $_{low}$ = 12.25, $F_{1, 23} = 34.6$, $p < .001$) with insignificant effect of the control and animated colours interaction. The above results reflect the four conditions that this thesis has manipulated. Only high levels of control and animated colours have allowed participants to feel the authenticity of the 3D laptops more than any other condition. This result comes in line with Fiore's (2008) empirical results that assert that a rich media, such as 3D virtual model, is one of the best tools which can simulate an actual experience with the online product. This research finds that a 3D virtual model often enables consumers to interact with (i.e., control) and to manipulate the product images (or colours). Moreover, in accordance with Li *et al.'s* (2001, 2002) studies, which posit that a high level of 3D media richness allows users to surpass an actual experience with the products, this research finds that control and animated colour constructs allow users to surpass an actual experience with the online products. The following section illustrates the importance of focusing on control and animated colour constructs to represent interactivity and vividness constructs.

Considerable research investigates and empirically tests the interactivity construct. However, there is little agreement on the definition or operationalisation of the web interactivity construct (e.g., Ariely, 2000; Klein, 2003; Liu and Shrum, 2002; McMillan and Hwang, 2002), which Heeter (2000, p. 75) describes as "*an overused and under defined concept*". For instance, previous research either defines interactivity as a multi-dimensional construct (to measure a website interactivity, e.g., Liu and Shrum, 2002; McMillan and Hwang, 2002), or proposes that interactivity concept should be measured with different antecedents (e.g., Johnson *et al*., 2006). Notwithstanding, researchers should focus on certain real elements of interactivity and vividness (when investigating the antecedents of 3D authenticity) rather than on the abstract constructs. To conceptualise the antecedents of the 3D authenticity construct, this thesis focuses on the narrowest definition of interactivity to maximise the perceived similarities between the direct experience and virtual experience. Specifically, this thesis uses the control construct to represent interactivity within the context of 3D virtual models. Moreover, this thesis focuses more on consumers' ability to control the content and form of the 3D product and easily interact with the 3D virtual model. In support of previous research (e.g., Ariely, 2000), this study finds that control represents a useful construct for 3D models. This result comes in accordance with Klein's (2003) study that focuses on the construct of user control as the best representative of interactivity.

Furthermore, whereas prior research defines vividness according to sensory breadth and depth, this study argues that the notion of vividness evolves and establishes in an immersive virtual reality environment facilitated by certain technology, including head-mounted sensory units that may allow users to touch, smell, see, and/or interact with virtual objects. In turn, within online retailers, the non-immersive VR interfaces currently generate and transmit only two main stimuli: visual and auditory (Kim and Forsythe, 2008; Suh and Lee, 2005). Some 3D products need visual and auditory channels for facilitating consumer products' inspection; others manifestly need visual aspects (Pimentel and Teixeira, 1994, p. 146, as cited in Suh and Lee, 2005). Following the efforts of Coyle and Thorson (2001) and Klein (2003), this thesis focuses on one aspect of vividness, namely, breadth while holding depth constant. Moreover, this thesis focuses on one aspect of the vividness breadth, namely the animated colours. Animated coloured pictorial images are used in this thesis to represent consumers' ability to see 3D products with different animated skins. Specifically, this study considers vividness of the visual imagery, such that consumers can see online products with different colours (skins) just as they would see them in reality. Animated colours may lead to a sense of perceiving the 3D product as real, according to research on online shopping (Klein, 2003; Schlosser, 2003). In accordance with Klein's (2003) and Hopkins *et al.'s* (2004) results, this thesis finds that a high level of media richness (i.e., animated colours and images) has a positive effect on 3D authenticity. Researchers might benefit from a tighter focus on specific aspects of vividness through illustration, such as this thesis has applied.

7.3.5 RQ5: The Utilitarian and Hedonic Constructs

Stage 4 results of the progressive levels of hedonic and utilitarian values indicate that the high levels of hedonic and utilitarian values lead to a high level of behavioural intention towards the e-retailer website. This result answered the fifth research question, and supported H_5. The above results reveal the importance of information as well as enjoyment, which 3D product visualisations produce, in enhancing participants' behavioural intention. Participants primed with the high utilitarian condition reported a higher behavioural intention when exposed to high hedonic versus low hedonic conditions ($M_{\text{High hedonic}} = 25.21$, $M_{\text{low hedonic}} = 10.8$, $F_{1, 23} = 36.05$, $p > .001$). However, participants primed with the low utilitarian condition reported a lower behavioural intention when exposed to high hedonic versus the hedonic conditions ($M_{\text{High hedonic}} = 15.3$, $M_{\text{low hedonic}} = 9$, $F_{1, 23} = 36.05$, $p > .001$). On the other hand, there was insignificant difference in participants' behavioural intention when the participants primed with the low level of hedonic condition (regardless of using the high level or the low level of utilitarian conditions; the mean differences between low utilitarian and high utilitarian = 1.833, $p > .05$). This result clearly posits the importance of the high level of hedonic value in comparison to the low level of hedonic value, and their effects on the behavioural intention. Moreover, it could be noticed from the interaction effect (a significant interaction effect between hedonic and utilitarian constructs, with a Wilks' Lambda of: .389, F (1, 23) = 36.074, $p < .001$, eta^2 = .611) that only in the case of having a high level of hedonic and utilitarian values is behavioural intention the highest. However, behavioural intention is still significant, but low, in the case of a high level of hedonic value and a low level of utilitarian value. The interaction effect highlights the importance of the high level of hedonic value and its impact on consumers' behavioural intention. The following illustrates the importance of using high levels of hedonic and utilitarian values and their impact on behavioural intention.

A value reflects consumers' perception of the main benefits that a consumption experience may provide (Holbrook, 1986). The utilitarian value often provides consumers with the appropriate information and facilitates their decision making. Moreover, a consumption experience may also provide consumers with the hedonic values, such as fantasies and playfulness, which enhance their pleasure (Holbrook and Hirschman, 1982). The way this research designs the 3D flashes not only enhances users' perceived knowledge, but also it boosts their actual knowledge regarding the laptop's attributes, features and characteristics. As a result, users report having a significant behavioural intention when using the high level of utilitarian value in comparison to the low level. This result comes in accordance with the previous research (e.g., Fiore and Jin, 2003; Fiore *et al.*, 2005a; Kim *et al.*, 2007; Klein, 2003; Li *et al.*, 2001; 2002, 2003; Suh and Chang 2006) that asserts the ability of a high level of 3D virtual model to enhance consumers' behavioural intention. 3D product visualisation increases consumers' involvement and encourages them to seek more information about the products. On the other hand, the high level of hedonic value enhances users' behavioural intention in comparison to the low level of hedonic value. The high level of hedonic value allows users to see the presented product with different skins, it allows users to have more fun (when zoon in or out on the virtual model), enjoyment and entertainment. This result support previous scholarly literature, which finds high levels of technological virtual models enhance users' behavioural intention (Kim and Forsythe, 2007, 2008; Fiore *et al*., 2005a, 2005b).

7.3.5 RQ 6: The Online S-O-R Framework Hypotheses Testing

Results of stage 5 show that control and animated colours impact the creation of 3D authenticity, which impacts hedonic, utilitarian and behavioural intention. In turn, 3D authenticity, hedonic and utilitarian values impact directly behavioural intention. This result answered the fifth research question, and supported H_{6a}-H_{6h}. In a highly competitive environment e-retailers need to find ways of attracting and retaining customers (Khakimdjanova and Park, 2005; Mummalaneni, 2005). A website with an authentic 3D visualisation is an important stimulus that usually helps e-retailers to find success and it often helps them to enhance the e-shopping environment (Khakimdjanova and Park, 2005; Park *et al*., 2008). Moreover, the conceptual framework results reveal the usefulness of the online S-O-R framework in interpreting and understanding the relationships among the control, animated colours (S), 3D authenticity, hedonic, utilitarian value (O), and the behavioural intention (R). The results of Stage 5 provide a strong evidence of the influence of the high levels of the control and animated colours on 3D authenticity which enables consumers to see a product simulated into 3D virtual model as a real authentic one. In support of other research (e.g., Coyle and Thorson, 2001; Klein, 2003), this thesis finds that the control and animated colours are the main antecedents of the 3D authenticity construct. Moreover, in support of the previous findings of Hopkins *et al*. (2004) and Coyle and Thorson (2001) studies, which finds a media richness (vividness) has a stronger impact on perceived realism (in comparison to user control), the empirical findings of this study assert that the animated colour construct is a stronger determinant of 3D authenticity than the control construct.

The control and animated colour constructs represent the main elements of the stimulus part (S). This result is in accordance with the theoretical studies of Sautter *et al*. (2004) and Manganari *et al*. (2009), which recommend researchers to investigate the effects of interactivity and vividness constructs (within the online atmospheric context) as the main stimuli that attract consumers' attentions towards navigating an online retailer when using the online S-O-R framework.

In the organism part (O), 3D authenticity has strong direct impacts on the hedonic and utilitarian values. These results confirm previous empirical findings for bricks-and-mortar environments that emphasise the importance of an online store environmental perception (Eroglu *et al*., 2003; Mummalaneni, 2005; Richard 2005). Moreover, these results support the theoretical ideas of Sautter *et al*. (2004) and Manganari *et al*. (2009) for bricks-and-clicks environments that emphasise the importance of adding virtual theatrics, realism, hedonic and utilitarian values constructs to enhance consumers' perception.

The above results cast light on the underlying process by showing that the 3D authenticity, hedonic and utilitarian values fully mediate the relationships between control, animated colours and behavioural intention. The importance of 3D authenticity as part of the perception process should be taking into consideration when designing an online virtual model. Previous research (e.g., Eroglu *et al*., 2003; Richards, 2005) has focused only on the emotional and cognitive aspects as the main components of the perception process, while holding the authenticity construct constant.

Unlike the previous studies that followed the online S-O-R framework (e.g., Eroglu *et al*., 2003; Mummalaneni, 2005; Richard, 2005) this study emphasises the importance of 3D authenticity in the organism part due to its highest impact on behavioural intention in comparison to the utilitarian and hedonic value. In line with Jahng, Jain, and Ramamurthy's (2006) empirical results, this study finds using 3D flashes to represent a richer media often helps consumers to understand verbal and non-verbal messages about the laptop characteristics. Moreover, a richer media, such as virtual models, often helps users to interact with the products, provides them with more information about the product, and facilitates their virtual experience. All the above characteristics of a 3D virtual model lead to superior outcomes.

This thesis results support conclusions of past research which posit that advanced technologies, such as 3D, provide consumers with enriched product information (Fiore and Jin, 2003; Fiore *et al*., 2005b; Li *et al*., 2001, Park *et al*., 2008) and hedonic value of the shopping experience (Li *et al*., 2003, Park *et al*., 2008). In line with Childers *et al*. (2001), Eroglu *et al*. (2003), and Richards (2005), this research finds that the hedonic value of 3D positively affects behavioural intention. In support of Ballantine (2005), this thesis finds that a high level of information (provided by 3D) enhances behavioural intention. These results support the importance of designing 3D product visualisation to increase the hedonic and utilitarian value.

In terms of the behavioural intention (R), this thesis finds that with 3D authenticity the hedonic and utilitarian values have positive and direct effects on behavioural intention. These results support previous scholarly literature on 3D product visualisation. For instance, Song *et al*. (2007) find a direct relationship between the enjoyment (extracted from navigating 3D virtual models) and willingness to purchase. Fiore *et al*. (2005a) report a positive relationship between a virtual model instrumental value, experiential value and behavioural intention. In addition, Fortin and Dholakia (2005) posit a positive relationship between involvement (that a 3D virtual model produces) and purchase intention. Kim *et al*. (2007) assert positive relationships between the enjoyment and involvement (that 3D virtual models can enhance) and behavioural intentions. Park and colleagues (2008) suggest positive relationships between 3D information, 3D hedonic and purchase intention. Finally, Suh and Chang (2006) point out a direct relationship between 3D product forms and purchase intention. The direct impact of 3D authenticity on behavioural intention suggests an important role of 3D authenticity in enhancing consumers' responses within the online retail context. The results also show strong direct impacts of 3D authenticity, hedonic and utilitarian value on behavioural intention (R). These results confirm that the shopping enjoyment created by 3D authenticity positively influence behavioural intention. Also, it illustrates that the shopping utilitarian value created by an authentic 3D positively influences consumers' behavioural intention. Stage 5 addresses Eroglu and colleagues' (2003) call to focus on specific aspects of the online retailer atmosphere. The results show the importance of focusing on a single stimulus, namely 3D product visualisation, and the significance of this stimulus in enhancing consumers' perceptions and virtual experiences.

7.3.6 Decomposition of Effect

Decomposition of effects analysis was conducted to assess the indirect effects of the predictor constructs on participants' behavioural intention. Following Hair *et al.*'*s* (2006) recommendation, with regard to the mediation effects, this thesis finds insignificant relationships between the independent variables (control and animated colours) and the dependent variable (behavioural intention). The results of the present study show that control and animated colours constructs have no direct effects on the behavioural intention construct. Instead, the addition of the control and animated colours constructs may be useful for their indirect effects on behavioural intention construct, mediated by the sense of 3D authenticity, hedonic and utilitarian values. Results of the present study illustrate that 3D authenticity has a significant direct effect on behavioural intention. In other words, the addition of the 3D virtual model to a website retailer often simulates an authentic (real) product which consumers can find in real offline retailers. The 3D authenticity, hedonic and utilitarian values are fully mediating the relationship between the control, animated colours constructs and the behavioural intention construct. The indirect effect (Table 6.39) of the animated colours on behavioural intention is significant (β = .399, p < 0.01) and reflects the importance of the animated colours within the 3D online product visualisation. The indirect effect of animated colours has been reported in many studies (e.g., Coyle and Thorson, 2001; Fortin and Dholakia, 2005; Hopkins *et al*., 2004; Griffith *et al*., 2001), which have articulated the importance of the indirect effect of media richness on consumers' responses. For instance, Tsang and Tse (2005) report the importance effects of hedonic salience: animated colour, animated text, and animated graphics variables on consumers' responses. However, the insignificant indirect effect of control (i.e., β = .077, p > 0.05) on behavioural intention agrees with other scholars (e.g., Hopkins *et al*., 2004), who assert the fact that control has insignificant direct and indirect influence on consumers' attitudes and behavioural intention. In addition, the indirect effect of animated colours suggests the importance of the mediating effects of the 3D authenticity, utilitarian and hedonic constructs on behavioural intention. Therefore, it is very important to use these mediators carefully if marketers want websites' users to have a virtual experience that simulates a direct experience (Fiore & Jin, 2003; Li *et al.*, 2002; Li *et al.*, 2001). Overall, the indirect effects in this model were not as strong as the direct effects. The above results clearly show that 3D product visualisation impacts users' perception by letting them realise that the 3D is an authentic product which often provides them with hedonic and utilitarian values.

7.4 DIFFERENCES AND GENERALISABILITY ACROSS SHOPPER GROUPS

The invariance analyses provide a better understanding of this study's conceptual model and its constructs' invariance validity. Also, it highlights the importance of the online S-O-R model applicability in the e-retailing area. Following a series of invariance analyses, it could be concluded that the conceptual framework was invariant in respect of the measurement model, structural model and latent mean model across gender, e-shopping experience, age, education level and study background. Of the fifteen invariance tests conducted, only three were non-invariant. This conclusion posits that overall all groups (females and males, more experienced and less experienced shoppers, undergraduates and postgraduates, young and old, Business-Social and Maths-IT-Engineering groups) conceptualise the model constructs and its variables (animated colours, control, 3D authenticity, utilitarian, hedonic, and behavioural intention) similarly. These results confirm the applicability of our model in the e-retailing area, unaffected by bias of gender, e-shopping experience, age, education level and study background (Lai and Li, 2005).

7.4.1 Gender

Following a series of invariance analyses, it can be concluded that this thesis model is invariant in respect of measurement model and structural model across gender. This result indicates that gender is not a moderator for the online S-O-R model. However, the difference (non-invariance) in the latent mean between male and female groups was significantly different with respect to behavioural intention (Table 6.43). This difference suggests that females tend to accept the idea of buying from the designed fictitious e-retailer more than the males group does. This result could be explained in light with the media richness theory which posits that high media richness (i.e., the use of different verbal and non-verbal cues) boosts users' performance (Dennis *et al*., 1999). The ability of the 3D flashes to enhance users' understanding of the laptops' features especially when using animations makes women's ability to make purchase decisions (based on non-verbal cues) easier. Moreover, this result supports Tversky and Morrison's (2002) findings regarding the ability of the animated graphics to increase females' comprehension and learning, which often facilitate females buying process. Further, since women are more "shopping for fun" in comparison to males (Hansen and Jensen, 2009); it seems that females have the potentiality of willingness to purchase from the fictitious site more than males.

7.4.2 E-shopping Experience

The invariance analyses across e-shopping experience show similarity in the measurement model, structural model, and latent mean model. The insignificant level of the structural weight level indicates that e-shopping experience is not a moderator for the online S-O-R model.

7.4.3 Age

The invariance analyses across age show similarity in the measurement model, structural model, and latent mean model. The insignificant level of the structural weight level indicates that age is not a moderator for the online S-O-R model. However, when this thesis investigates the mean table (Table 6.51), the control construct mean has a significant difference between the two groups. This means that the more than 20 years (old) group is lower (-.221) than the 20 years old or less (young) group in perceiving the control construct. The difference (non-invariance) in the latent mean between the young and old groups suggests that the young group tends to accept the idea of controlling the 3D more than the old group.

7.4.4 Educational Levels

The invariance analyses across educational levels show similarity in the measurement model, structural model, and latent mean model. The insignificant level of the structural weight level indicates that educational level is not a moderator for the online S-O-R model.

7.4.5 Study Backgrounds

The study backgrounds invariance analyses results reveal similarity in the measurement and latent mean models. However, the structural model results reveal non-invariance (significant) differences between Business-Social group and Maths-IT-Engineering groups. In other words, the study background is a significant moderator between the effect of 3D authenticity on hedonic values, and the effect of hedonic value and behavioural intention. The impact of 3D authenticity on hedonic is significantly higher for students with Maths-IT-Engineering backgrounds than those with Business-Social backgrounds. Maths-IT- Engineering group tends to accept that the 3D authenticity and the novelty of the 3D flash increase the level of fun and entertainment. On the other hand, the Business-Social group does not accept that hedonic values (entertainment) may result in a positive behavioural intention towards the fictitious online retailer.

With regard to the un-standardised direct, indirect and total effects (Table 7.1), students with Maths-IT-Engineering backgrounds perceive the total effects of the 3D authenticity construct on the behavioural intention (.618) more than those with Business-Social backgrounds (.306). This may be because the Maths-IT-Engineering group's ability to understand and criticise the novelty of the 3D more than those with Business-Social backgrounds. However, the Business-Social group perceives the total effects of the utilitarian values (.169) on behavioural intention less than the Maths-IT-Engineering group. On the other hand, the Maths-IT-Engineering group perceives the total effects of hedonic values (.524) on behavioural intention more than the Business-Social group (.029). In contrast to the Maths-IT- Engineering group, which perceives the direct effect of the hedonic values (.524) on behavioural intention more than the utilitarian values (.349), the Business-Social studies group perceives the direct effect of utilitarian values on behavioural intention (.169) more than hedonic values (.029). These results can be explained as follows. In comparison to the Business-Social group, the Maths-IT-Engineering group bought on average more laptops online ($M_{\text{Maths-IT-Engendering}}$ = 1.33, $M_{\text{Business-Social}}$ = 1.3, Table 6.4) than the Business-Social group. This result might reveal that the Business-Social group members are more interested in a laptop's features and characteristics than its entertainment features because of their qualitative approach.

Table 7.1 Results of participants' study backgrounds un-standardised indirect, direct and total effects estimates

Direct, indirect and total effects estimates (Business-Social group)

Predictor variables	Behavioural intention toward the online retailer		
	Indirect effects	Direct effects	Total effects
Animation colours	.221	------	.221
Control	0.030	------	.030
3D authenticity	.075	.230	.306
Utilitarian value	------	.169	.169
Hedonic value	------	.029	.029
R^2			.34

Direct, indirect and total effects estimates (Maths-IT-Engineering) group

Predictor variables	Behavioural intention toward the online retailer		
	Indirect effects	Direct effects	Total effects
Animated colours	.503	------	.503
Control	0.121	------	.121
3D authenticity	.068	.550	.618
Utilitarian value	------	.349	.349
Hedonic value	------	.524	.524
R^2			.34

7.5.1 Theoretical Implication and Contributions

This research adds to the marketing literature the notion of 3D authenticity, and a valid scale to measure it. It is the first study to have connected and used the antecedents of 3D authenticity (control and animated colours) in conjunction with the 3D authenticity construct. The emergence of the notion of 3D authenticity makes it easier for marketers to use and apply this notion within the e-retailer context. Previous scholarly literature (e.g., Coyle and Thorson, 2001; Klein, 2003; Li *et al*, 2002, 2003) has used and applied the notion of 3D telepresence to reflect consumers' virtual experience in the bricks-and-clicks context and has used a scale that has been established to measure telepresence in an immersive VR. Moreover, previous online retail researchers (e.g., Coyle and Thorson, 2001; Klein, 2003) have used the same scale that scholars of immersive virtual reality used to measure telepresence in 3D product visualisations. Having such a scale within the online retail context may confuse marketers and users, because what measures, for example, a TV telepresence might not be applicable in the 3D in a computer context.

Marketers should focus on specific aspects of interactivity and vividness when designing 3D websites (Fiore *et al.*, 2005a; Fortain and Dholakia, 2005). For instance, the empirical support, for the control construct as the best representative of interactivity, solved a long debate among previous researchers who have considered interactivity to be a multi-dimensional scale (e.g., Lui and Shrum, 2002; McMillan, 2002) or a construct with more than one antecedent (e.g., Johnson *et al.*, 2006). When it comes to virtual models, this thesis prefers focusing on the narrowest, most relevant aspects of interactivity (i.e., control). The control construct in this thesis adds to Klein's (2003) study. In other words, Klein's (2003) study focused on the control over information acquisition. In turn, this thesis focuses on control over the format (visual presentation) and content of information. Furthermore, whereas prior research defines vividness according to sensory breadth and depth (e.g., Steuer, 1992), this thesis argues that researchers might benefit from a tighter focus on specific aspects of vividness through illustration, as this thesis has done.

This research makes an important contribution to the online retailer atmospheric literature by providing a rich explanation of how authenticity of 3D virtual models adds more information, fun and enhances consumers' responses towards the online retailer. The 3D authenticity construct has a significant, positive impact on hedonic, utilitarian values and behavioural intention. Moreover, this thesis addresses Eroglu's and colleagues' (2003) call to focus on specific aspects of the online retailer atmosphere. The results show the importance of focusing on a single stimulus, namely 3D, and the significance of this stimulus in enhancing consumers' perceptions and virtual experiences. The results of this thesis also support the theoretical ideas of Sautter *et al*. (2004) and Manganari *et al*. (2009) regarding the importance of adding virtual theatrics to the online store environment.

7.5.2 Managerial Implications and Contributions

This research empirically finds that 3D authenticity, hedonic and utilitarian values are significant determinants of behavioural intention. Retail website managers should pay more attention to 3D authenticity antecedents, i.e., control and animated colours, when designing their 3D virtual models. Including real colours and flashes that consumers can easily control often leads to a more authentic online experience. Moreover, retail website designers can enhance consumers' virtual experience by focusing more on the utilitarian and hedonic values. Any 3D flash should include the essential information that consumers seek (i.e., perceived and actual knowledge), and consumers should be able to click on any part of the 3D flash to get instant information about the laptop.

Previous researchers have focused on the ability of 3D to reflect general information (perceived sensation knowledge) to the audience, such as the overall appearance of the products (e.g., Fiore *et al*., 2005a). Therefore, this study does encourage marketers to focus more on adding the proper and relevant information to the 3D flashes they design. A helpful 3D site should enable consumers to realise both perceived knowledge (external appearance of the product) and actual knowledge (basic information that might help customers to make their purchase decision easily, according to Jiang and Benbasat, 2005; Jiang and Benbasat; 2007; Sue and Lee, 2005).

The direct impact of hedonic value on behavioural intention indicates the importance of hedonic value within the 3D context. Many consumers might search a company site for the sake of innovation and enjoyment, which may result in actual behaviour towards the online retailer. A 3D product visualisation ability to enrich consumers' sensation is very important in driving the consumers' attention towards the online retailer. Moreover, the interaction effects of the hedonic and utilitarian levels inspire marketers and managers to focus more on the high level of hedonic values. Adding a 3D flash with more hedonic value often enhances consumers' behavioural intention (Kim and Forsythe, 2007).

Website developers should improve users' perceptions of the authenticity of the 3D flashes. To achieve this, website developers should consider the importance of control and animated colours. The empirical results of this research reflect the importance of participants' ability to easily zoom in or out of a laptop, and rotate it (control construct). Moreover, participants' ability to change the laptop's colours (animated colours) is considered another important aspect to enhance users' perception of the authenticity of the 3D product visualisation.

The significant effect of 3D authenticity on hedonic and utilitarian values suggests that a well designed 3D flash not only helps participants to get the proper information easily, but also allows them to have more fun from navigating the 3D flashes. It is very important for website developers to build innovative 3D flashes that can reflect hedonic and utilitarian values. Website developers should take advantage of technological advances to develop and update the online retailers' 3D flashes. Otherwise if all the competitors, in the same industry, use the same 3D flashes, then the animation will not attract the consumers' attention (Fasolo *et al.*, 2006). Managers and website designers should work together to ensure that the 3D product visualisation provides customers with the complete and accurate information they need. In addition, marketers should decide what information (or knowledge) to focus on before developing any 3D flash.

It should be accepted that developing 3D flashes is not a money free issue. Nevertheless, many companies have already claimed to improve their sales as a result of designing and using 3D flashes. For example, J.C. Penny, eBags and Wal-Mart claimed that their online sales have increased 10% to 50% after using rich media such as 3D flashes (Demery, 2003). Moreover, Demery (2006) posits that the numbers of companies who are investing in 3D virtual models is increasing steadily because these companies are seeing the potential for selling more products. Nantel (2004) asserts that consumers shopping online for clothing are 26% more likely to purchase from sites that have 3D virtual models than from sites that have not. Moreover, Fiore (2008) posits that media richness is an important way to differentiate retailers.

Wagner (2000) asserts that online retailers with 3D product visualisations may reap benefits that extend beyond sales. For example, 3D increases site stickiness: users will spend more time on the online retailer, which leads to more opportunities to learn more about the products, interact with them, and build trust and confidence.

Using a 3D product visualisation often helps organisations to build their brand images easily and quickly (Wagner, 2000). For instance, Lands End (My Virtual Model) has more than 450,000 virtual models that users can try the clothes on. In addition, the wide spread of social networks and blogs may enhance the positive word of mouth towards companies which have 3D virtual products. As a result organisational reputation and brand image are highly likely to increase (Wagner, 2000).

Finally, according to the Social Issues Research Centre (SIRC, as cited in Herrod, 2007) study it is expected that "by 2020 virtual commerce (v-commerce) will replace e-commerce", and the development of 3D virtual models (such as 3D virtual shopping malls) will be leading the whole industry by 2020. All the above advantages will help users to get more tangible online shopping experiences.

7.5.3 Methodological Implications and Contributions

Previous research has examined 3D product visualisation in apparel products (Fiore *et al*., 2005a; Fiore *et al*., 2005b; Kim *et al*., 2007; Lee *et al*., 2006; Li *et al*., 2003), watches and bedding (Li *et al*., 2003), a desktop computer and a computer table (Suh and Lee, 2005; Suh and Chang, 2006). This study explores a new scope of 3D product visualisation and empirically tests the effects of using 3D product visualisation of laptops on behavioural intention.

To test the effects of 3D product visualisation on consumers' behaviour, previous research has either tested the effects of the progressive levels of 3D antecedents and their impact on 3D product visualisation (e.g., Coyle and Thorson, 2001; Klein, 2003), or has proposed certain relationships between 3D antecedents and consequences, and then tested these relationships (Fiore *et al.*, 2005a, Yang and Wu, 2009). This study combines the two previous methods and it distinguishes itself by designing a fictitious website retailer that has the progressive levels of 3D (laptops) antecedents and consequences. Based on the progressive levels' results, this study found that the high levels of the independent variables have the greatest impact on the dependent variables. The next step was to test the relationships between the proposed constructs taking into account only the high levels of the 3D antecedents and consequences (using the online S-O-R model). To conclude, this study has designed a 2×2 within subjects design to test the effects of the progressive levels of control and animated colours on 3D authenticity (the dependent variable), and then another 2×2 within subjects design to test the effects of the progressive levels of the hedonic and utilitarian values on behavioural intention (the dependent variable). Based on the results of the progressive levels, this thesis designed a flash that contains only the high levels of the control, animated colours, hedonic and utilitarian construct to test the proposed online S-O-R model.

7.6 FUTURE RESEARCH

Further research may investigate this thesis model using a non-student sample. Moreover, other researchers might apply this study in a non-electrical context (e.g., clothing). Doing this will clarify if this model is applicable to other areas. Even though Pimentel and Teixeira (1994, p. 164) find that visual stimuli are the main sensory cues in producing the virtual experience, further research may add and test other stimuli to investigate how auditory and visual vividness may influence 3D authenticity, for example by simulating real sounds. Future research may also take advantage of the 3D authenticity scale and investigate the effects of 3D authenticity on consumers' trust, branding image, and word of mouth (or mouse). In addition, a comparison study might be valid within the context of the online S-O-R framework using 3D product visualisation, particularly between the developed and developing countries. Using this research conceptual framework, further research is welcome to study the cosmopolitan nature of London's students and to report whether the invariance analysis is significant or insignificant within this context. Such cultural invariance analysis may enhance marketers' and practitioners' understanding of the influences of cultural differences on the participants' behaviour. Future research is invited to develop 3D virtual models which consumers can customise and to investigate the effects of adding the customisation options on brand image, customer satisfaction and customer loyalty.

7.7 CLOSING REMARKS

This study explored a new scope of 3D product visualisation and empirically tested the effects of using 3D product visualisation of laptops on behavioural intention. This thesis found that using the notion of 3D authenticity is better than the notion of 3D telepresence if marketers and website designers are interested in simulating 3D products. The results of the current research proved that 3D product visualisation enhanced participants' hedonic value more than the 2D static pictures. However, no significant difference has been discovered regarding the impact of the 3D product visualisation and 2D static picture utilitarian values. The design of this study is original in using websites that have progressive levels of control, animated colours, hedonic and utilitarian values. Specifically, the website that contains 3D product visualisation with both hedonic and utilitarian values distinguishes the current study from others. This research investigated the effects of the progressive levels of control and animated colour constructs on 3D authenticity and the effects of the progressive levels of hedonic and utilitarian constructs on behavioural intention. Using the results of the high level of each construct, this research focused on studying the impact of 3D product visualisation antecedents (S); the control and animated colours, on consumers' perception process (O); 3D authenticity, hedonic and utilitarian values; and the impact of consumers' perception on their responses (R), i.e., behavioural intention. The online S-O-R model considers being the first model that connects 3D product visualisation antecedents to the 3D authenticity, and the impact of the focal construct, 3D authenticity, and its consequences on behavioural intention. The main purpose of using the online S-O-R framework was to fill the gaps in the previous literature that has studied the impact of the online store atmosphere.

In support of the previous theoretical studies, this research finds that when using the online S-O-R framework it is very important to focus on the stimulus part (S); control and animated colours. This study empirically finds that control and animated colours have positive and direct relationships on 3D authenticity. 3D authenticity has positive and direct effects on hedonic and utilitarian values, and, finally, 3D authenticity, hedonic and utilitarian values have positive and direct effects on behavioural intention. The results of this research results support conclusions of past research that posits that advanced technology, such as 3D, provides consumers with enriched product information (Fiore and Jin, 2003; Fiore *et al.*, 2005b; Li *et al.*, 2001) and hedonic value of the shopping experience (Li *et al.*, 2003). In line with Childers *et al.* (2001), Eroglu *et al.* (2003) and Richards (2005), this thesis finds that the hedonic value of 3D positively affects behavioural intention. In support of Ballantine (2005), this thesis finds that a high level of information (provided by 3D) enhances behavioural intention. These results support the importance of designing 3D product visualisation to increase hedonic and utilitarian values. Also, the results of this thesis support the theoretical ideas of Sautter *et al.* (2004) and Manganari *et al.* (2009) regarding the importance of adding virtual theatrics to the online store environment. The area of this study is an important one (since it is related to a search and experience product), whereas previous research examined 3D product visualisation of apparel products (Fiore *et al.*, 2005a; Fiore *et al.*, 2005b; Kim *et al.*, 2007; Lee *et al.*, 2006; Li *et al.*, 2003), watches and bedding (Lie *et al.*, 2003), and a desktop computer stimulus (Suh and Lee, 2005; Suh and Chang, 2006). This study explored a new scope of 3D product visualisation and empirically tested the effects of using 3D product visualisation of laptops on behavioural intention.

The design of this study is original in using websites that have progressive levels of control, animated colours, hedonic and utilitarian values. Specifically, the website that contains 3D product visualisation with both hedonic and utilitarian values distinguishes the current study from others. This is the first model that connects 3D product visualisation antecedents and consequences, and the impact of the focal construct, authenticity of the 3D product visualisation, and its consequences on behavioural intention. Previous research has either empirically tested the progressive levels of 3D antecedents on telepresence or realism (e.g., Klein, 2003), or it investigated the relationships between the 3D telepresence and other constructs (e.g., attitude, product knowledge, such as Coyle and Thorson, 2001). In turn, this research investigated the effects of progressive levels of control and animated colours on 3D authenticity, and the effects of the progressive levels of hedonic and utilitarian on behavioural intention. As a result, this research considered the high level of each construct and investigated the effects of Stimulus on Organism and the effect of the Organism on consumers' Responses using the online S-O-R framework.

7.8 CONCLUSIONS

Despite widespread discussions and various definitions and measurements of VE, this study notices that previous scholars, within the online retail context, consider the notions of 3D telepresence as virtual substitutes for actual experience with the products. However, the telepresence and presence constructs are not necessarily wholly appropriate concepts for marketers since they represent a process of mental transportation into other areas or immersion into an illusion environment. Such notions may not be particularly helpful for marketers and website designers who are concerned with 3D product visualisation of real products. Instead, this thesis proposes the 3D authenticity construct, which refers to simulating a real product authentically online. This thesis introduced a new construct, namely 3D authenticity, to reflect customers' virtual experience, so that they can feel the authenticity of the 3D products. This study, therefore, first discussed the notions of telepresence or presence and their antecedents in the immersive virtual reality (IVR) environment then proceeded to explain applications of non-immersive virtual realties (NIVR, i.e., an online retailer context). This study also offered a new definition and measurement scale for the construct of 3D authenticity. Moreover, this study answered the following research questions (using five stages).

RQ1) How do consumers perceive 3D product virtualisation (telepresence) compared with 3D product authenticity on online retailers' websites?

The differences between the notion of 3D telepresence and the 3D authenticity construct have been discussed and analysed during this stage. The results revealed that participants agreed that the demonstrated website retailer is best described as an authentic site with authentic product, rather than an illusion site or being there.

RQ2) How do consumers perceive 3D hedonic values compared with 2D hedonic values on online retailers' websites?
RQ3) How do consumers perceive 3D product visualisation utilitarian values compared with 2D utilitarian values on online retailers' websites?

The main differences (compressions) between 2D and 3D experiences were analysed and results found that (i) 3D flashes provided participants with more fun and entertainment than the 2D flashes, (ii) 3D and 2D product visualisations offered participants with almost the same information (i.e., perceived and actual knowledge).

RQ4) Who do different levels of 3D control and animated colours influence 3D authenticity?

The impact of the progressive levels of 3D authenticity antecedents (control and animated colours constructs) on the perceived 3D authenticity construct was analysed. The results revealed that the high levels of control and animated colours have the most impact on the creation of 3D authenticity.

RQ5) Who do different levels of 3D hedonic and utilitarian levels influence behavioural intentions?

The impact of the progressive levels of hedonic and utilitarian values constructs on the behavioural intention was analysed. The results revealed that the high levels of hedonic and utilitarian values have the most impact on consumers' behavioural intention.

RQ6) Who do control, animated colours, 3D authenticity, hedonic and utilitarian values affect consumers' behavioural intention?

The effects of high levels of control, animated colours, 3D authenticity, hedonic value, utilitarian value, and behavioural intention were tested in stage 5. This thesis developed a conceptual framework and tested the relationships in the proposed model using the online S-O-R framework. The results revealed the usefulness of the online S-O-R framework in understanding the relationships among the control, animated colours (S), 3D authenticity, hedonic, utilitarian value (O) and the behavioural intention (R). In accordance with Klein (2003) this research finds that control and animated colours are the main tools that enhance consumers' virtual experience. The 3D authenticity construct enables consumers to experience online products without directly inspecting them and provides consumers with a sense of having a direct experience (Coyle and Thorson, 2001). The direct impact of 3D authenticity on behavioural intention demonstrates an important role for 3D authenticity in enhancing consumers' responses within the online retail context.

With regard to the online S-O-R paradigm, it could be concluded that a proper design of website atmospherics (e.g., animated colours and control) often enhanced online shoppers' internal states (hedonic and utilitarian value), which usually ended up with positive outcomes. For instance, a pleasant store atmosphere can entice online shoppers to visit the online retailer (Manganari *et* *al*., 2009), builds a positive attitude towards the online retailer (Childers *et al*., 2001; Coyle and Thorson 2001; Fiore *et al*., 2005a), and boosts shoppers' behavioural intentions (Richard, 2005). A website with an authentic 3D atmosphere is an important stimulus that can help e-retailers to find success. The results also support the theoretical ideas of Sautter *et al*. (2004) and Manganari *et al.* (2009) regarding the importance of adding virtual theatrics to the online store environment. In brief, there has been little empirical research about the impact of using a single stimulus in the online S-O-R model. Previous studies investigated the impact of the whole environment (using many stimuli) on consumers' responses. This research provides a rich explanation of how authenticity of the 3D virtual models adds more information and fun (3D authenticity has a significant, positive impact on hedonic and utilitarian values); and enhances consumers' responses towards the online retailer.

7.9 CONTRIBUTIONS

This thesis makes a significant contribution to the e-retailing literature by introducing a new and valid construct, namely 3D authenticity, and it is the first study that has connected and used the antecedents of 3D authenticity (control and animated colours) in the 3D authenticity construct. The emergence of the notion of 3D authenticity makes it easier for marketers to use and apply this notion within the online retailer context.

This research makes an important contribution to the online atmospheric literature by providing a rich explanation of how authenticity of the 3D virtual models adds more information and fun; and enhances consumers' responses towards the online retailer. The main purpose of using the S-O-R framework was to fill the gaps in the previous literature that studied the impact of the online store atmosphere. With regard to the previous studies on this area, few have tested the influence of one stimulus alone. Previous studies investigate the impact of the whole environment (using many stimuli) on consumers' responses. To the best of the researcher's knowledge, this research is the first study in the UK that uses a UK sample to investigate the effects of using 3D product visualisation on consumers' perceptions and responses using the online S-O-R paradigm. This study focused on the impact of 3D product visualisation antecedents (S): control and animated colours, on consumers' perception process (O), i.e., 3D authenticity, hedonic and utilitarian values, and the impact of consumers' perception on their responses (R), i.e., behavioural intention. The investigation of the S-O-R framework in this thesis has provided us with a further understanding of the relationship development, which is useful for both academics and practitioners.

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9 APPENDICES

Appendix 1:

3D authenticity *vs* 3D telepresence (Stage 1)

Appendix 2a:
The 3D and 2D conditions (hedonic value, Stage 2)

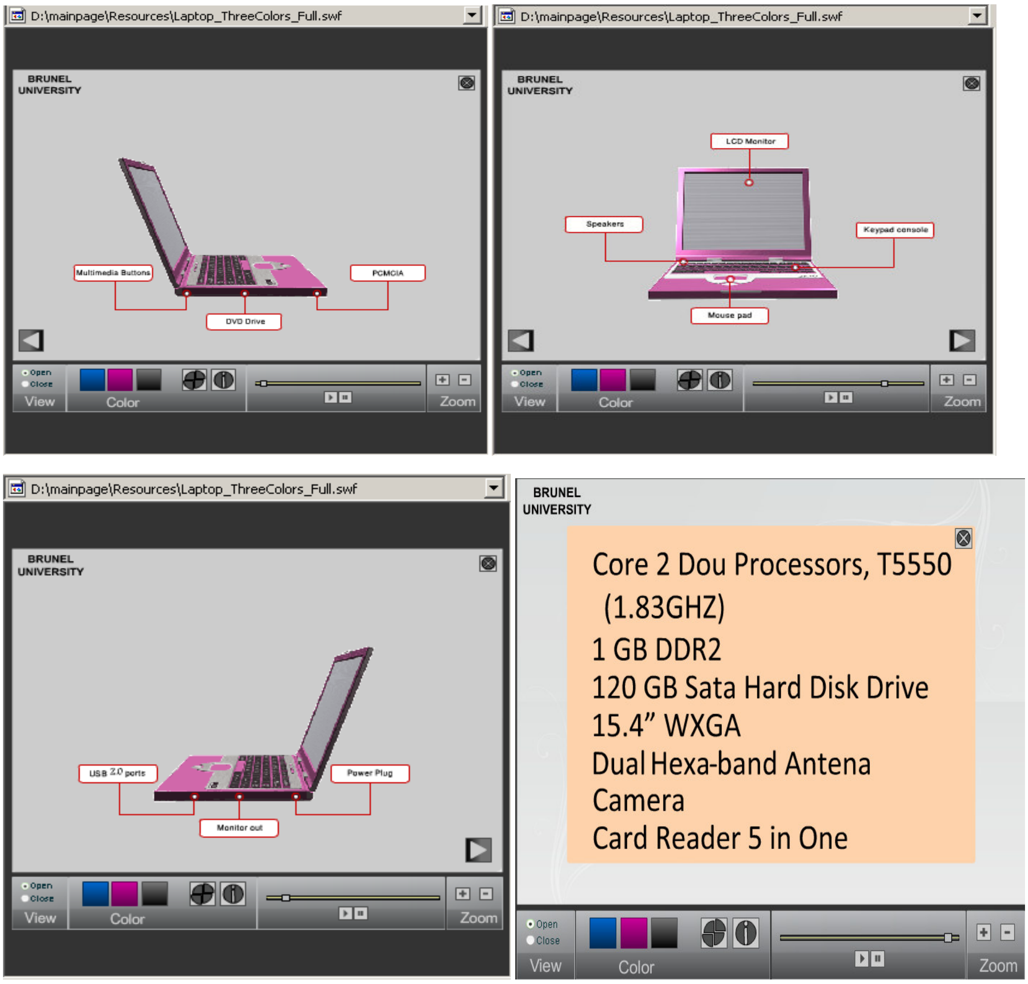
Stage 2: 2D Hedonic Values

Stage 2: 3D Hedonic Values

Appendix 2b:
The 3D and 2D conditions (utilitarian value, Stage 2)

Stage 2: 2D Utilitarian Values

Stage 2: 3D Utilitarian Values

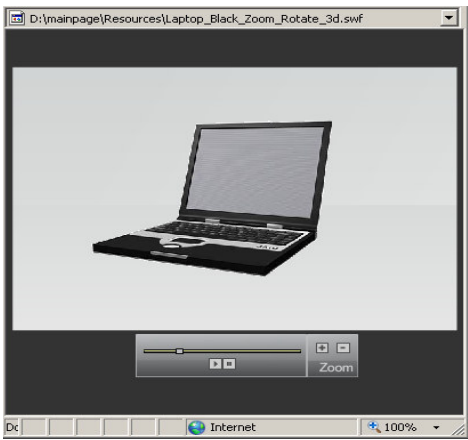


Appendix 3:
The progressive levels of Stage 3

The first condition in Stage 3

The second condition in Stage 3

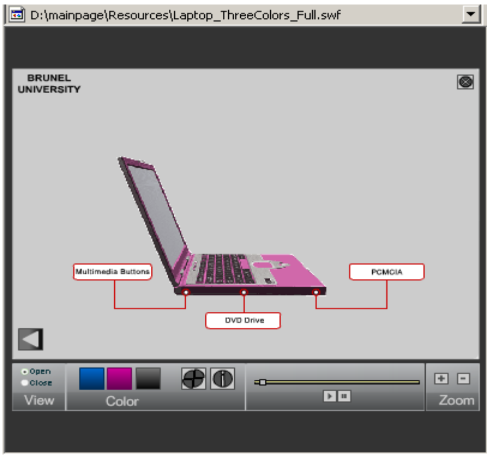
The third condition in Stage 3

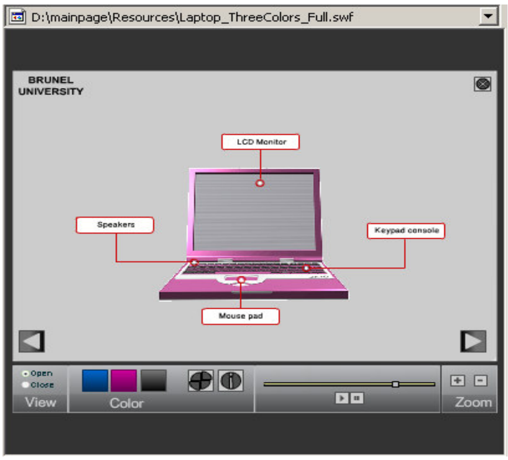


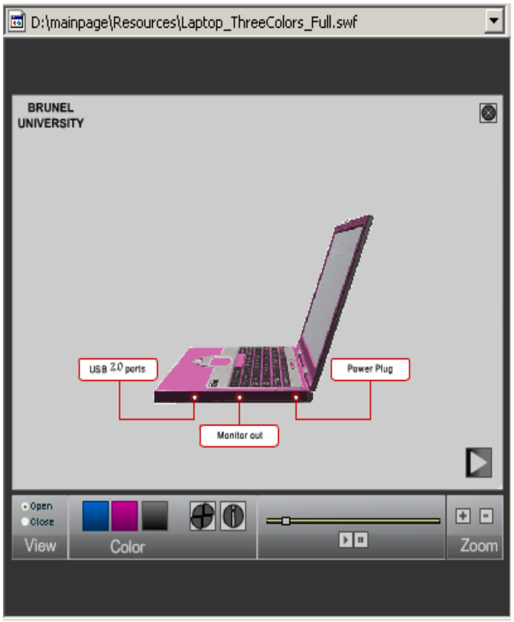
The fourth condition in stage 3

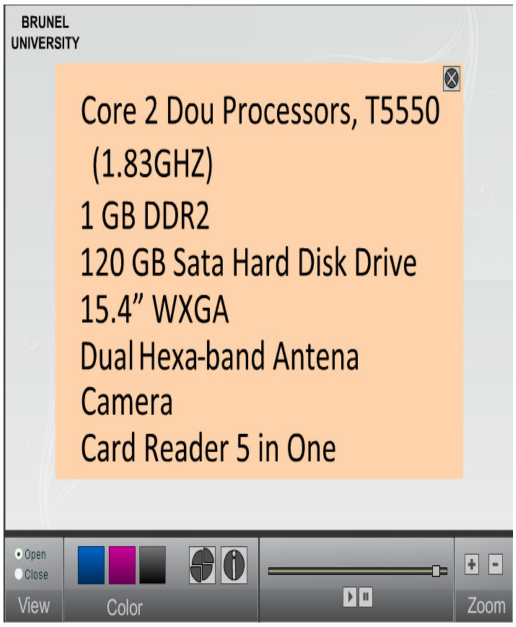
Appendix 4:
The progressive levels of Stage 4

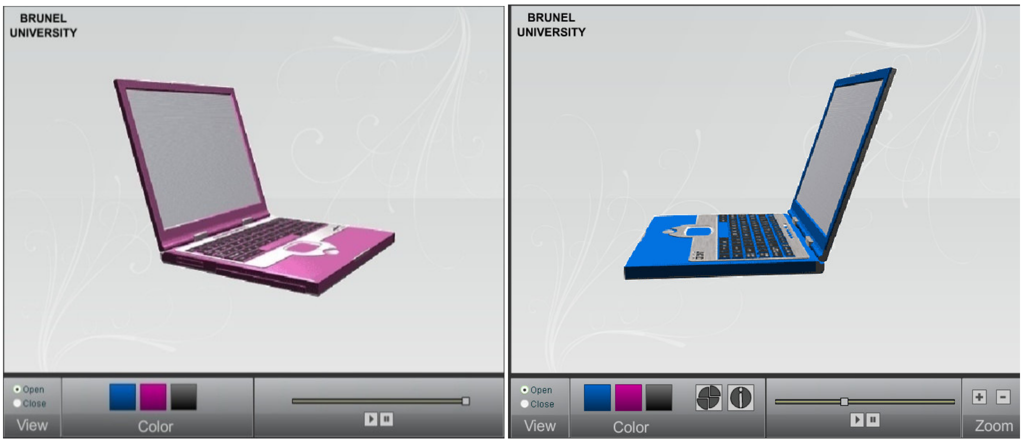
The first condition in Stage 4



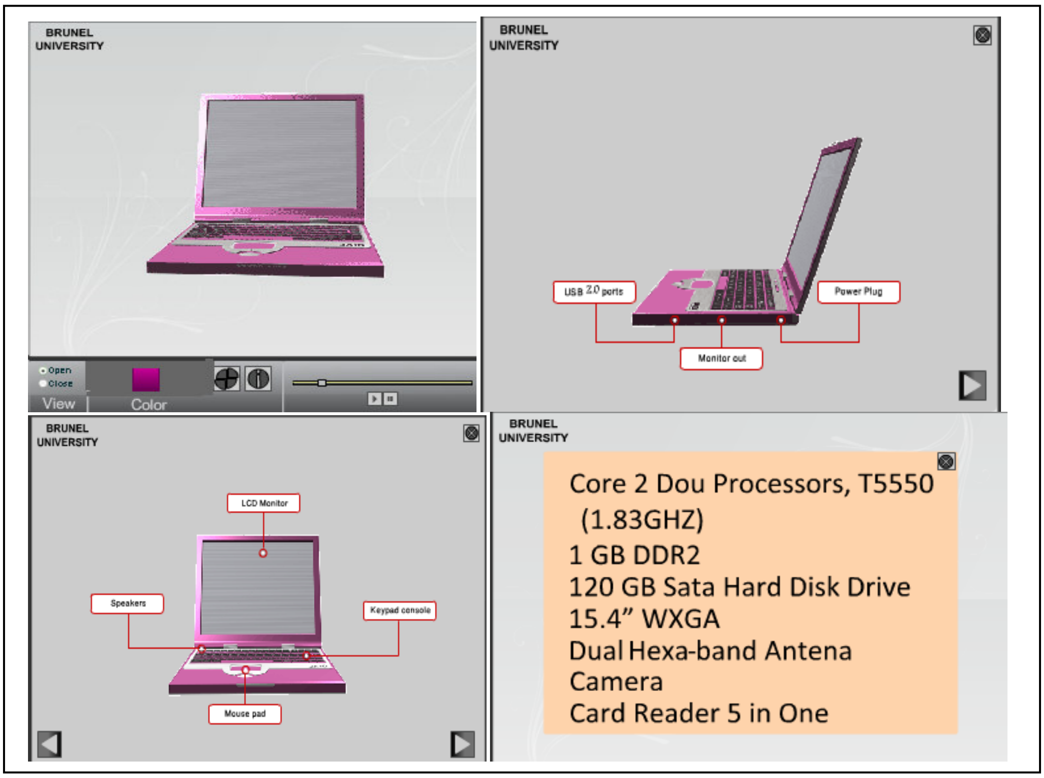




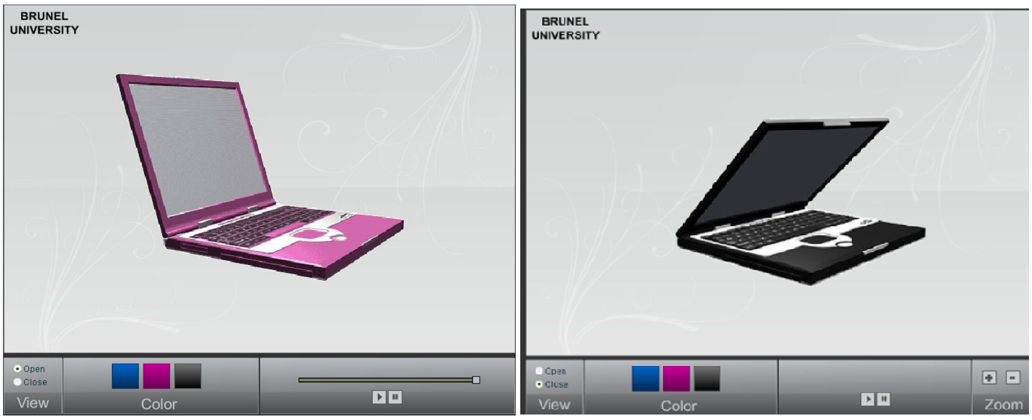




The second condition in Stage 4

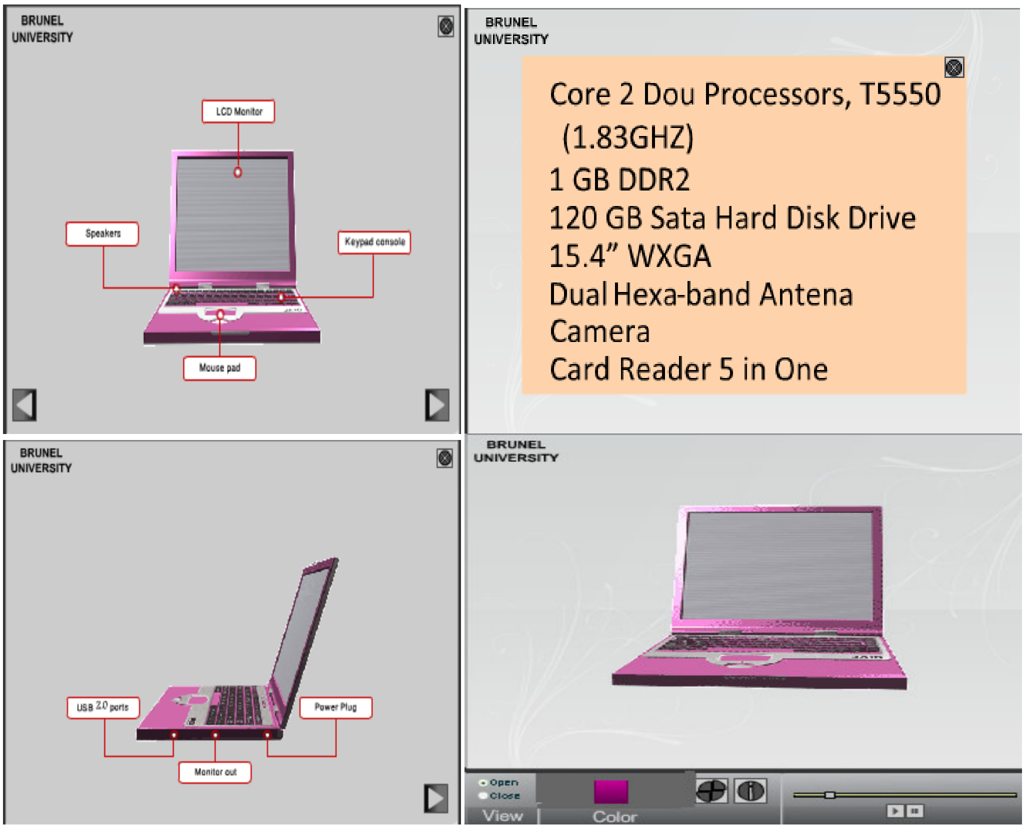


The third condition in Stage 4



The fourth condition in Stage 4

Appendix 5:
The S-O-R framework (Stage 5)



Appendix: 6
Brunel University
Business and Management School

I am a PhD research student at Brunel University-West London conducting a study to investigate the effect of using product visualisations on consumer responses. The research title is:

Modelling 3D product visualisation for the online retailer.

Your participation is voluntary. If you do not wish to participate, simply discard the questionnaire. Responses will be completely anonymous; your name will not appear anywhere on the survey. Completing and returning the questionnaire constitutes your consent to participate.

All of the information you kindly provide will be treated as completely confidential and it will not be possible for anyone to identify the information you supply.

The questionnaire will only take 20-25 minutes of your time to fill out. Please visit the following site to answer the questions www.brunel.ac.uk/~cbpgrra .

Your cooperation is highly appreciated and will contribute to the success of this study. If you have any questions or concerns, please contact me Raed.Algharabat@brunel.ac.uk or my supervisor Charles.Dennis@brunel.ac.uk

I would be very grateful if you fill out this questionnaire.

Thank you

Raed Algharabat.

Please tick the box that matches your status:

1- Do you use the Internet for e-shopping? Yes ☐ No ☐

2- How many times did you buy a laptop online?

I have not ☐ Once ☐ twice ☐ three ☐ others ☐

3. What laptop do you have at the moment? ………………………………………………

4- How long have you been using the Internet?

Don't use ☐ less than 1yr ☐ 1- 2 yrs ☐ More than 2 yrs ☐

5- How often do you use the Internet for surfing e-retailers per week?

Don't use ☐ 1-2 hrs ☐ 3- 4 hrs ☐ More than 4 hrs ☐

6-Gender: Female ☐ Male ☐

7- Marital Status: Single ☐ Married ☐ divorced / separated ☐ other ----

8- Age: 20 or under ☐ 21- 30 ☐ 31- 40 ☐ 41 -50 ☐ 51- 60 ☐ 61 + ☐

9- Level of education:

Bachelor ☐ Post graduate ☐ PhD student ☐ PhD holder ☐

10- Your annual income:

Under £ 15,000 ☐ £ 15,000 – 24,000 ☐ £ 25,000 -34,000 ☐ £ 35,000 – 44,000 ☐

£ 45,000 + ☐

11- The country that best describes your culture is -----------------------------------

Amplify if relevant, e.g. UK-Afro-Caribbean, UK-Asia.

No	Statements					
Control indicators: After surfing the 3D sites		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
1.	I felt it was very easy to zoom in/out the laptops.	1	2	3	4	5
2.	I felt that I could choose freely what I wanted to see.	1	2	3	4	5
3.	I felt that I had a lot of control over the content of the laptop's options (i.e. angles and information).	1	2	3	4	5
4.	I felt it was easy to rotate the laptop the way I wanted.	1	2	3	4	5
5.	I felt I could control the laptop movements.	1	2	3	4	5
6.	I felt that I had the freedom to choose the sequences of the laptop appearance (i.e., colours, shapes, angles and information).	1	2	3	4	5
7.	I felt that 3D laptops responded to my orders appropriately (e.g., when I click on the blue colour the laptop became blue. When I click on information I got it).	1	2	3	4	5
Vividness indicators: After surfing the 3D site: I think,		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
8.	It provided me with accurate visual information about the laptops.	1	2	3	4	5
9.	Multicolour in the 3D laptop let me easily visualize what the actual laptop is like.	1	2	3	4	5
10.	There are lots of colours on 3D laptop websites.	1	2	3	4	5
11.	Colours brightness of the 3D laptop let me	1	2	3	4	5

	visualize how the real laptop might look.					
12.	The laptop illustrated by 3D was very colourful	1	2	3	4	5
13.	The 3D site enables me to choose and to see different colours of the same laptop	1	2	3	4	5
3D Authenticity: After surfing the 3D sites:		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
14.	Being able to zoom in/out and rotate the laptop let me visualize how the laptop might look in an offline retailer.	1	2	3	4	5
15.	3D Creates a product experience similar to the one I would have when shopping in a store.	1	2	3	4	5
16.	3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	1	2	3	4	5
17.	3D Let me feel like I am dealing with a salesman who is responding to my orders.	1	2	3	4	5
18.	3D let me see the laptop as if it was a real one.	1	2	3	4	5
3D Telepresence: After surfing the 3D sites:						
19.	I forgot about my immediate surrounding when I was navigating through 3D sites.	1	2	3	4	5
20.	While I was on the 3D sites, I sometimes forgot that I was in the middle of an experiment.	1	2	3	4	5
21.	While I was on the 3D sites, my body was in the room, but my mind was inside the world created by Brunel site.	1	2	3	4	5
22.	While I was on this site, the world generated by Brunel (3D) was more real or present for me compared to the “real world.”	1	2	3	4	5

3D Hedonic Value If I were actually to shop for laptops online, shopping with Brunel 3D sites:		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
23.	Would be truly a joy	1	2	3	4	5
24.	Would be like an escape.	1	2	3	4	5
25.	Would be truly enjoyable	1	2	3	4	5
26.	Would be enjoyable for its own sake, not just for the items I may have purchase.	1	2	3	4	5
27.	Would let me enjoy being immersed in an existing new product.	1	2	3	4	5
28.	Would enhance me to continue shopping, not because I had to, but because I want to.	1	2	3	4	5
29.	Would help me having a good time because I was able to act on the 'spur-of-the-moment	1	2	3	4	5
30.	Would be like the excitement of the hunt.	1	2	3	4	5
31.	Would help me to forget my problems.	1	2	3	4	5
32.	Would be a sense of adventure	1	2	3	4	5
33.	Would be a very nice time out.	1	2	3	4	5
3D Utilitarian value After surfing the 3D site with the information and If I were actually shopping for a laptop online, this 3D site would create a shopping experience that would:		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
34.	Give me more information about the product.	1	2	3	4	5
35.	Help me make a better decision about the product	1	2	3	4	5
36.	help me buy the right product	1	2	3	4	5
37.	Aid me in evaluating the laptop items.	1	2	3	4	5
38.	Help me in finding what I am looking for.	1	2	3	4	5
39.	Help me to accomplish what I want.	1	2	3	4	5

		Very Unwilling	unwilling	neutral	willing	very willing
Behavioural intention: After surfing the 3D sites:						
40.	Assuming the laptops on the websites suit your taste or needs, how willing would you be to purchase a laptop from this online store	1	2	3	4	5
41.	After seeing the web site, how likely is it that you would buy a laptop from this online store.	1	2	3	4	5
42.	I would be willing to purchase a laptop through this online store.	1	2	3	4	5
43.	I intend to buy a laptop from this online store.	1	2	3	4	5
44.	I would be willing to recommend this online retailer to my friends.	1	2	3	4	5
45.	In the future, I would very probably shop at this online retailer	1	2	3	4	5
46.	I would visit this online retailer again	1	2	3	4	5
No	**Static sites:**					
2D high hedonic value: Surfing the static picture sites (with different colours of the same product) would create an experience that:		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
50.	Was truly a joy	1	2	3	4	5
51.	Was like an escape.	1	2	3	4	5
52.	Was truly enjoyable	1	2	3	4	5

53.	Was enjoyable for its own sake, not just for the items I may have purchase.	1	2	3	4	5
54.	I enjoyed being immersed in the existing product.	1	2	3	4	5
55.	I continued shopping, not because I had to, but because I want to.	1	2	3	4	5
56.	I had a good time because I was able to act on the 'spur-of-the-moment	1	2	3	4	5
57.	Was like the excitement of the hunt.	1	2	3	4	5
58.	Let me forgot my problems.	1	2	3	4	5
59.	Gave me a sense of adventure	1	2	3	4	5
60.	Was a very nice time out.	1	2	3	4	5
<u>2D utilitarian</u> If I were actually to shop from Brunel site, the static pictures site would create a shopping experience that would:		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
61.	Give me more information about the product	1	2	3	4	5
62.	Help me make a better decision about the product	1	2	3	4	5
33.	Help me buy the right product	1	2	3	4	5
64.	Aid me in evaluating the items.	1	2	3	4	5
65.	Help me in finding what I am looking for.	1	2	3	4	5
66.	Help me to accomplish what I want.	1	2	3	4	5

Appendix 7

Brunel University
Business and Management School

I am a PhD research student at Brunel University-West London conducting a study to investigate the effect of using product visualisations on consumer responses. The research title is:

Modelling 3D product visualisation for the online retailer.

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All of the information you kindly provide will be treated as completely confidential and it will not be possible for anyone to identify the information you supply.

The questionnaire will only take 20-25 minutes of your time to fill out. Please visit the following site to answer the questions www.brunel.ac.uk/~cbpgrra . Your cooperation is highly appreciated and will contribute to the success of this study. If you have any questions or concerns, please contact me Raed.Algharabat@brunel.ac.uk or my supervisor Charles.Dennis@brunel.ac.uk

I would be very grateful if you fill out this questionnaire.

Thank you

Raed Algharabat.

Please tick the box that matches your status:

1- Do you use the Internet for e-shopping? Yes ☐ No ☐

2- How many times did you buy a laptop online?

I have not ☐ Once ☐ twice ☐ three ☐ others ☐

3. What laptop do you have at the moment? ……………………………………………….

4- How long have you been using the Internet?

Don't use ☐ less than 1yr ☐ 1- 2 yrs ☐ More than 2 yrs ☐

5- How often do you use the Internet for surfing e-retailers per week?

Don't use ☐ 1-2 hrs ☐ 3- 4 hrs ☐ More than 4 hrs ☐

6-Gender: Female ☐ Male ☐

7- Marital Status: Single ☐ Married ☐ Divorced / separated ☐ other ----

8- Age: 20 or under ☐ 21- 30 ☐ 31- 40 ☐ 41 -50 ☐ 51- 60 ☐ 61 + ☐

9- Level of education:

Bachelor ☐ Post graduate ☐ PhD student ☐ PhD holder ☐

10- Your annual income:

Under £15,000 ☐ £15,000 – 24,000 ☐ £25,000 -34,000 ☐ £ 35,000 – 44,000 ☐ £45,000 + ☐

11- The country that best describes your culture is ----------------------------------

Amplify if relevant, e.g. UK-AfroCaribbean, UK-Asia.

<u>3D Authenticity</u> **(1)** After surfing the 3D site **(HC-HA)**		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
1.	Being able to zoom in/out and rotate the laptop let me visualize how the laptop might look in an offline retailer.	1	2	3	4	5
2.	3D Creates a product experience similar to the one I would have when shopping in a store.	1	2	3	4	5
3.	3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	1	2	3	4	5
4.	3D Let me feel like I am dealing with a salesman who is responding to my orders.	1	2	3	4	5
5.	3D let me see the laptop as if it was a real one.	1	2	3	4	5

<u>3D Authenticity</u> **(2)** After surfing the 3D site **(HC-LA)**		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
1.	Being able to zoom in/out and rotate the laptop let me visualize how the laptop might look in an offline retailer.	1	2	3	4	5
2.	3D Creates a product experience similar to the one I would have when shopping in a store.	1	2	3	4	5
3.	3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	1	2	3	4	5
4.	3D Let me feel like I am dealing with a salesman who is responding to my orders.	1	2	3	4	5
5.	3D let me see the laptop as if it was a real one.	1	2	3	4	5

<u>3D Authenticity</u> **(3)** After surfing the 3D site **(LC-HA)**		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
1.	Being able to zoom in/out and rotate the laptop let me visualize how the laptop might look in an offline retailer.	1	2	3	4	5
2.	3D Creates a product experience similar to the one I would have when shopping in a store.	1	2	3	4	5
3.	3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	1	2	3	4	5
4.	3D Let me feel like I am dealing with a salesman who is responding to my orders.	1	2	3	4	5
5.	3D let me see the laptop as if it was a real one.	1	2	3	4	5
9.	While I was on this site, the world generated by Brunel (3D) was more real or present for me compared to the "real world."	1	2	3	4	5

<u>3D Authenticity</u> **(4)** After surfing the 3D site **(LC-LA)**		**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
1.	Being able to zoom in/out and rotate the laptop let me visualize how the laptop might look in an offline retailer.	1	2	3	4	5
2.	3D Creates a product experience similar to the one I would have when shopping in a store.	1	2	3	4	5
3.	3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance)	1	2	3	4	5
4.	3D Let me feel like I am dealing with a salesman who is responding to my orders.	1	2	3	4	5
5.	3D let me see the laptop as if it was a real one.	1	2	3	4	5

Behavioural intention: **(1)** After surfing the 3D site **(HH-HU)**		Very Unwilling | unwilling | neutral | willing | very willing
1.	Assuming the product on the website suit your taste or needs, how willing would you be to purchase laptops from this online store	1 2 3 4 5
2.	After seeing the web site, how likely is it that you would buy a laptop from this online store.	1 2 3 4 5
3.	I would be willing to purchase a laptop through this online store.	1 2 3 4 5
	Statement:	**Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree.**
4.	I intend to buy a laptop from this online store.	1 2 3 4 5
5.	I would be willing to recommend this online retailer to my friends.	1 2 3 4 5
6.	In the future, I would very probably shop at this online retailer	1 2 3 4 5
7.	I would visit this online retailer again	1 2 3 4 5

Behavioural intention: (2) After surfing the 3D site (HH-LU)		Very Unwilling	unwilling	neutral	willing	very willing
1.	Assuming the product on the website suit your taste or needs, how willing would you be to purchase laptops from this online store	1	2	3	4	5
2.	After seeing the web site, how likely is it that you would buy a laptop from this online store.	1	2	3	4	5
3.	I would be willing to purchase a laptop through this online store.	1	2	3	4	5
	Statement:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
4.	I intend to buy a laptop from this online store.	1	2	3	4	5
5.	I would be willing to recommend this online retailer to my friends.	1	2	3	4	5
6.	In the future, I would very probably shop at this online retailer	1	2	3	4	5
7.	I would visit this online retailer again	1	2	3	4	5

<u>Behavioural intention:</u> **(3)** After surfing the 3D site **(LH-LU)**		Very Unwilling	unwilling	neutral	willing	very willing
1.	Assuming the product on the website suit your taste or needs, how willing would you be to purchase laptops from this online store	1	2	3	4	5
2.	After seeing the web site, how likely is it that you would buy a laptop from this online store.	1	2	3	4	5
3.	I would be willing to purchase a laptop through this online store.	1	2	3	4	5
	Statement:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
4.	I intend to buy a laptop from this online store.	1	2	3	4	5
5.	I would be willing to recommend this online retailer to my friends.	1	2	3	4	5
6.	In the future, I would very probably shop at this online retailer	1	2	3	4	5
7.	I would visit this online retailer again	1	2	3	4	5

<u>Behavioural intention:</u> **(4)** After surfing the 3D site **(LH-LU)**		Very Unwilling	unwilling	neutral	willing	very willing
1.	Assuming the product on the website suit your taste or needs, how willing would you be to purchase laptops from this online store	1	2	3	4	5
2.	After seeing the web site, how likely is it that you would buy a laptop from this online store.	1	2	3	4	5
3.	I would be willing to purchase a laptop through this online store.	1	2	3	4	5
	Statement:	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree.**
4.	I intend to buy a laptop from this online store.	1	2	3	4	5
5.	I would be willing to recommend this online retailer to my friends.	1	2	3	4	5
6.	In the future, I would very probably shop at this online retailer	1	2	3	4	5
7.	I would visit this online retailer again	1	2	3	4	5

Appendix 8:
Focus group Transcripts

Focus group 1:

Researcher: hi every one, this afternoon we will surf number of website. Before starting I want you to tell, in couple of mints, about your last e-shopping trip, any one has any recently.

Ebay, I bought an ipod from this site

have any one of you use 3D in e-shopping:

The main purpose of this focus group is to examine telepresence. Before starting I want you to surf Sony Website, laptop, where you can see and manipulate the 3D, in this site you can see the product in different colours, you can zoom the product in, out rotate the product. Please surf this site for a couple of mints.

For people who did this, I want to ask you, how do you feel and think about using the 3D in Sony site:

P1F1: it makes my choice of the product easier, as I am seeing this product in an offline retailer. It is good because I have the feelings of being in an offline retailer.

IN: any thing ells?

P2F1: I totally agree with him, but the point is the size, I mean the 3D size is nice but still I cannot get the actual size of the product and I am wondering about the size since this 3D did not give me the actual size.

P8F1: if I want to buy a laptop and to pay such money I need to see it in an offline retailer.

Tell me how do you feel about 3D?

IN4: I like it.

Researcher: what elements make you feel that you have been transported into an offline retailer?

P4F1: I felt that I can touch it by hand, moving it but not moving it by hand. But at least you can see the back the type, changing the colour, like you want to the shop and see a range of the product where you can turn it rotate the product zooming the product in/out.

PAR: it does not give me more information about the product.

Researcher: this is something ells, because there is different sites, in some there is some information by using 3D where if you highlighted certain points in laptop, then the information will come up saying that this part (x) is (y), this the capacity… again coming to P4F1's point of view she said that your ability to zoom the product in/out, rotate the product. All these stuff, give you the felling of being transported into the offline retailer, and she said something ells about the colour. Do you think that the colour is active and silimllar to the same colour you might see in an offline retailer?

P4F1: I did not ask my self this question I assume that as far as I concerned now to the colour but it did not really come to my mind.

Raed: Do you have a feeling of like you are dealing with a salesman, so you said please show me different colour of the white colour or the pink colour, I mean this responsiveness, what do you think about the responsiveness of the 3D. is obeying your orders/ demand?

P5F1: It is better than a sales man:

Yes it is since you can choose any colour you want.

Do you think this feeling has some thing to do with the speed of responding? I mean the colour?

Yes, I felt it.

Researcher: There is another site actually, it's more for ladies. Go to the Ezface site. It is a site for make up. In this site you can put your picture and then choose what make up suit you. Again I want you to surf this site?

Researcher: Tell me how do you feel and think a bout this site, taking into your considerations that you can upload your picture and make the make up for your own self.

P7F1: Can I use my picture?

Researcher: Yes you can put your own face.

Researcher: How do you feel?

P8F1: It is good

P7F1: It is very nice

Researcher: Does it give you any feeling?

P7F1: if the question is weather to buy or not? it is something difficult.

Researcher: basically, the question is about how you feeling and thinking about this site.

It is all bout paint you can see how different combinations work and look on you.

P4F1: I think it is very different to what I can do in a shop, in way that if I went to a shop I have got foundation I can put in my hand and try another one. But the main problem is I can’t feel the colour like the case of the laptop but here I doubt the colour. Unlike the lab top case where I was sure about the colour. Here, the colour might be different. I am not sure about.

YA,

P8F1: one of the problem you got here,

P4F1:

P7F1: more than the laptop, in the laptop what you see is what you get, but the make up….

P9F1: and even in a laptop you don’t care that much, but

So I need to use a natural face,

Some times you need to know what colour you need.

In a laptop what you see you get, the make up is different

And even

Researcher: I need you now to surf the last site, which is my virtual model, this is actually a virtual model for clothes, this site enables you to simulate your body, giving the model your Wight, height, your hair stile, hair colour, and after this you can start mix and match the cloths from this site to see how such clothes might suit you.

P8F1: how can you tell about the size problem in this model is what concerns me.

Researcher: You can see that you have categories in this virtual model, If you go to any one of them you can identify your sizes, you are telling the virtual model these things, and you will simulate a virtual model to suit your measurement .

Researcher: You can choose any company or go to lands’end, H&M and then try to choose different clothes and mix and mach it.

P8F1: The problem is with different sizes; some times it did not match your exact size.

Researcher: This virtual model actually produced to solve all your try on problems. Basically you are giving the model (clothes) your different sizes. For example in UK your size may be 5 but in your country……………

P8F1: But I cannot tell how exactly the virtual model size will fit me.

Researcher: I got the problem.

The same clothes the same size might not work for all people. Some people have bigger hypes than others in reality, so I think what you simulate is not always right.

Researcher: when buying, some times you are not buying a new brand. i.e. if you see a new brand and you liked it, then you might not buy it online, but you need to see it online, but usually, let say when it comes to let say certain pair of jeans or T-shirt you used to buy it:

P8F1: when it comes to jeans it is okay but many things like

P2F1: the comfort of jeans differ from area to area.

P8F1: what if you want to buy but many things a jacket or a dress online. I usually will not do it.

Some people might go to the virtual model and see how the clothes fit them. This is a good idea

P3F1: when you are on an offline retailer there are huge number of the products which makes it difficult to select any one because, it is human nature that when there comes increase in quantity then the selections comes limited. So if you have online opportunity then you can minimize your search through kea words to select particular product.

P4F1: I think its all depend on the person ability to know, because, not necessarily, the shape it self what the product does and what it doesn't or the colour, the precious decision like to buy or not to buy. Yet, in clothes

P5F1: the intangibility nature of online purchasing, make it difficult to buy. So I prefer buying my clothes from an offline retailer where I can see and try them on.

Researcher: intangibility problems are the main reason for online retailers to use 3D in their sites.

P5F1: but again this intangibility nature makes me retain the product.

Researcher: what hedonic and utilitarian values you have from surfing these three sites, I mean giving more information about the product, have a feelings of entertainment, fun innovation.

Ya:

Researcher: Lets start with the laptops; what do you think about the laptop.

P6F1: Yes, defiantly, it gives me more information about how the product how it looks from inside, the colours.

P3F1: according to product selection point of you, I think so that lap top are easy to buy online process becaue they have fiexed parameters in size, colour and speed, but we can not compare with this for buying clothing thorug online. One reason is their size and colour choice at real time.

P8F1: for me basically, if I want to spend money to buy a laptop I prefer to go to an offline shop, and to see it.

Raed: At the moment I am speaking again about utilitarian and hedonic values that you might have from surfing 3D not at your responses.

P2F1: I think you can get more information, so in my case I know what's going on

…………………………………………………………………………………………

P4F1:

Sharef: one reason I think so for online purchasing is selction of prouducts can save our time and money. Because through your computer you can visit numbers of shops and can compare prices of product that saves not only your time to physically visit shop but also plenty amount of money.

Do you think it is saving time, and gives more information:

Ya.

It s convenience

Researcher:

P5F1: I think there is entretinment in all sites. Especially the make up one, even thought I wouldnot buy from it.

Researcher: Is it joyful not joyful.

It s Fun.

Ya.

The final think actually is about the responses,…

You said something about perceived risk, do you think that using 3D might reduce perceived risk or not?

P2F1: whenever you make a desion it might lower the risk, but I think the risk is over there.

Researcher: Any thing about intension to buy

P8F1: if you speaking about buying a laptop then I prefer to going and have a look to an offline retailer and buy it.

Researcher: I am

P6F1: it depends on how much you already know about a lap top. If you know a little abit about it you will go to offline shop and get more information. But if had already some idea, about the lap top, you might not much warry and you will buy it online.

Researcher: I am speaking generally about . ……

P7F1: if I know a bout the product I will buy it

Researcher: it is not buying a product it is like "I like it" for example about thinking of the product

P7F1: I will do that; it might narrow my choices; right now I might go and shop for the clothes.

P6F1: It can help me narrow down the process.

Researcher: Are going to tell a friend about this.

Yes,

P2F1: It stacked in the mind, it's joyful.

P4F1: for laptop I go and buy, but clothes or make up.

Focus group (2) 1/07/08.

Researcher: Today actually we are going to surf three sites:

On the screen you have three sites, we will go for the first site which is Sony.co.uk, in this site you will see a laptop. This laptop is illustrated in 3D. now I need you for couple of mints to surf this 3D, try to change the colour, try to move it, zoom it in/out.

Researcher: basically, for prople who surf this, could you please tell me about your experience in online shopping while the other end surfing?

P2F2: I bought ………………..

P1F2: I bought some from tesco, amozen.

P3F2: Laptop.

Now, I need you to tell me how do you feel and think about surfing this site, Sony laptop.

P1F2: you ask me,

Researcher: Ya

P3F2: just its comfortable, convenient and more interesting.

P1F2: yes I think its better than the regular picture.

P1F2: I would never buy my laptop online. I prefer going to the shop

Researcher: I am asking you now about your feeling,

P3F2: I would never buy something (my laptop or) online. I never buy clothes online

Researcher: at the moment, I am asking you about your feelings

P1F2: it is going to be 3D or pictures it would not make any difference to my choice Raed: again, I got your point, what are you feeling, you did this

Now do you have any feeling like for example, you are surfing a real thing

P1F2: no

P4F2: I do like it really, it looks

Researcher: so you prefer it

P1F2: I prefer real things…………

Researcher: why do you prefer it

P1F2: I can see the back and the front

Researcher: Does this giving you any feelings of (for example) you can do certain things in offline retailer (what you are doing with the 3D I mean). I mean you zoom the laptop in/out, you said that you prefer using 3D over 2D (static pictures). Now my question is, this feeling coming from your ability to feel the product more.

P1F2: you cannot feel the product, you can just see things from different angles, learn more about it, I do not know if I can feel it, I don't feel it like more real, but I feel like I know more about it.

P4F2: for me actually when taking my decision (ok) 3D is , but first before I take my final decision to by a laptop online I have to go to the shop and see the produc, because the first time its likely different to see the product on the internet and feel it.

Researcher: actually what I am trying to discuss with you here, the first item for telepresence, and telepresence is a feeling of being (lets say) transported into another area, so the question (now) directly is; after zooming in/out, rotating the product, do you have this feeling like being in an offline retailer?

P1F2: no I don't, I don't feel like being in an offline retailer, I think its an additional benefit of an online retailer,

Researcher: what the basic elements you like to.

P1F2: that you can change the colur and moving it.

P4F2: I 'd like to see more things, like information…………

Researcher: What things you like in 3D

P2F2: its convenience/interesting than common site, but not any thing more.

Researcher: will go to the second site, it is called virtual model, lets surf it for couple of mints, basically, the virtual model is a model simuluates your body and you can give it your tall, your hight, your weight, your hair colour, hair shape, save it . And after this you can start mix and match the clothes you like.

Researcher: and you can also choose any company you like, they have got three companies; for example H&M is one of them, you can go directly to this site.

P1F2: how can I do this?

Researcher: go to personlize, face shape……..

Researcher: You can zoom it rotate the virtual model to see how clothes fit you.

Researcher: how do feel and think about this site?

P1F2: this site, the virtual model

Researcher: yes, the virtual model.

P4F2: it's nice to play around it. But it would not, I mean, it is not something retailer/manufacturer more or less to haunt it items …………

P1F2: do you know why:

Researcher: why

P1F2: because people prefer to see address (top modern), you can have decide that the top modern is more quality, the more likely you have branding staff of buying and having driving force over (to buy something) instead of have your self, because your self, it is okay what kind of improvement can these item make for me so you speak zero.

P4F2: and this is new about, although you can some measurement you cannot, it doesn't have you accurate measurement, you cannot do it on virtual model.

Raed: Now things like feel of respoenses on a lap top and virtual model. ……………………………………………… do you think that it seems like a salesman or sales person: when you ask I need this or that.

It can especially when choose different colours like the blue.

Researcher: do you think that you have two-way communication between you and the Pc.

Researcher: Do you feel that this virtual model obey your orders?

P4F1: ya

Researcher: we will surf the last site and then we will have a general take about certain things; this is a make up site, you can upload your picture here instead of having this picture, and again you can go and make you own, let's surf it for couple of mints and have a chat about it.

P1F2: it is the only site that makes sense.

Researcher: How do you feel and think about the site

P4F2: I like playing around it. It is fun and some inside…..like the block for other one like the foundation it does tell me any thing, what you looking at is the colour of the face…….

P1F2: but you can replace your own picture

P4F2: even in my picture…when it coming to which colour face you would you like to have you don't know how the foundation going to look like only, because some time you can adopt the colour here right your hand when you wear it you can see the different.

Researcher: you have any thing?

P1F2: basically its very beautiful you can identify what colour suits you, on the other hand it is going to be processor play arounf with the product, because now I don't know what brand it is.

Researcher: there is no brand, so it will not affect your attitude.

P1F2: no, no it is not like the brand, the brand going miss call you under face, I don not buy such stuff if I don't know the brand……………………………..

Once you surf the three sites, did you feel that the three sites add some enjoyment to you. You like it, its fun?

P1F2: I like this one (make up)

Researcher: what about the virtual model?

P4F2: it is fun but not ….one.

Raed: any innovation things in it?

P4F2: there is around.

Researcher: do you have any let's say (getting more) information from this sites the three sites?

You said that you like the mak up site it was fun. Does any think comes to your maind that it might add some information to you about the characteristics of the product, about the laptop?

P4F2:

After surfing the three site do you think they are funny you liked them

P2F2: ya, it is not something common, you can get more information, for example in the case of the lap top you can get some.

Does any of the sites adds any information to you?

P3F2: yes it adds.

Researcher: Final thing is something about how such 3D forms from the three different sites might affect your responses or behaviour? I mean do you think that using such things may create some intentions to buy in your case? Or you going to patronize the offline retailer i.e. that you see this (product) here and after a while you decide to go and see it in an offline retailer?

P4F2: maybe some product……………………

Are you planning to say something about this experiment to your friends? I mean that this site has 3D you can surf it.

P4F3: I will not run, until it comes to a conversation.

Yes I will. Me too

Do you think that using 3D in any website retailer might reduce your perceived risk. I mean some times you are afraid of buying certain product because you are not aware of certain characteristics of this product. Lets make it easir if you have the information about the product you know the product and you saw the product on a t.v would you buy it

P4F3: I think it should (you know) reduce the perceived risk and more than if you like it and you can see it in your laptop you should have a clue. Even within inside with the main topic you got a laptop you organise you pictures you have I think laptop is more interesting.

That's it. Do you like to add any thing,,,,,

Thank you.

Focus group (3): 2/7/08.

Researcher: Good afternoon every one, today we are going to surf three sites, in each site there is a virtual model or 3D, we will surf each site for couple of mints and then we will have a chat about the three sites. As you can see in bottom of your screen there is three sites, so please click the second site (Ya). This is actually a Sony site and this ia a lap top illustrated in 3D (Am) for a couple of mints I need you to surf this site, try to move this (am) laptop, try to change the colour, try to learn more about the features and charactrestics of this pc, now to make it easy you have three things: you can change the colour, you can (actually) zoom in/out the laptop and you can see certain dimensions of the laptop, so please go a head.

Researcher: now I want you to tell me how do you feel and think about the 3D in Sony site?

P2F3: now the problem is at the concept of physical aspect of the product, I have no problem. Yet, (but) the physical aspect in that (laptop) product may be 20 percent, I mean the most important thing we need to ask you, the reliability of the battery (cant see). When it comes to what colour I want, the physical aspects you want to be, yes its enough up to that point. But when we going to come to what kind of software it has (which is more important) in buying a laptop, the battery life, the size of the screen, when I compare it with other laptop. I cannot make a decision based on this website.

P1F3: people going to check the (features) design of the laptop or first check the software of a computer, so what are the capabilities of other things, then I come and see the design, what colour I want to gain and what so on. I don't know if (you know) they are already (expect as to know the capability) of the computer then you know the other thing, this is very helpful in know what colour you want.

P2F3: if the question is will buy this online just by looking at this. NO. I might use it as exploration theory to compare it with other product (yes). But I need to go to the floor and see it my self.

P3F3: for me I cannot see the size, and also the keyboard I cannot see them.

P4F3: if I am try to buy a laptop and I see this colour and these movement I will buy it, but I know about laptop (the brand name) and theses things and its provided (price and every things) I will check I will not buy it. I will go and check it in the store then I will buy it.

Raed: after surfing this site do you have this feelings of (like) being transported into a high street retailer. I mean, your ability to zoom the product, rotate it, see it in different colour, does it come to your mind that it similar to the shopping in a high street retailer?

P3F3: May be this eager you to check for more information.

P1F3: ya the same I am feeling that I am not getting more information.

Researcher: we will speaking more about the getting more information about the product at the moment we are using such thing might affect your feeling in a way……………

P2F3: No

P1F3: me personally, I have bought laptop online and I have checked several stock and (you know) and as I said before I look at the design of the laptop I first look at the pre agenda I look for a laptop. So when I decided it I want this laptop with this capability I want to see it in the shape of how it looks.

P2F3: Yes, the last thing you think about is the shape. How it looks in different colour is the last thing, more important is the attribute of the product.

Researcher: I need you to go to google, and write down Dell.co.uk. From there choose home laptop and surf it. (At the main while the researcher was helping the participants in surfing and navigating this site). This site provides certain information that you looking for. Now what do you think about this (site, comparing with) the previous 3D site.
P2F3: yes ofcours it is much better.
P4F3: much more better.
P2F3: I can feel the size (now) you can feel the product (now) every aspect. If we combine the two Websites together……
Researcher: the question is how do you feel and think about the site (again)?
P5F3: There is some point about how you (perception you know).
Researcher: Perception (ok)
Researcher: Now do you think that that adding the 3D add any entertainment element, I mean you feel that good, you feel happy in the first site? You zoom it in/out, see it in different colour
P4F3: sense of fun.
P2F3: If you give the two (assuming the two website of the same product) give me the features over there you give me look at it from all sides, ya it will make my experience (my entertainment experience) much more enjoyable.

P1F3: you know that's the case, at the end of the day when you want to buy the product, so the more detail you have the best. Then you will enjoy it (you know)

P2F3: we need more detail on the criticism of other product, comparing it to other products. My product does this other do not do.
P2F6: if you give me two options which one which based on the previous one (playful) but the percentage I would say this one. The percentage is high here.

Researcher: I need you to surf the second site which is related to my virtual model. This is a clothes retailer looking in the site now and according to your gender, choose your virtual model, this is a virtual model. This virtual model you can adopt to your self. There is a good feature here (actually) you can create your own virtual model, you can identify the wight, hight of the virtual model, the colour and shape, the shape of your hair, the colour of your hair, so easily you can personalize it. I need you to surf this site for couple of mints and to mix and match different bice of clothing and see how it works with you? You can zoom the virtual model in/out rotate the virtual model. (at the main while the researcher was helping the participants to complete their tasks).

Researcher: so again how do you feel and think about the sites?
P2F3: give me how the colours of the clothes if buy them …… of course the background has different colour to show you different environment. So based on this website I can buy my clothes online.
Researcher: but you cannot buy a laptop online.
P2F3: no.
P3F3: I can buy my clothes.

P2F3: I can buy my clothes online, it's much more fun, much more enjoyable and it gives you (you do not have to go to the shop/retailer) you going need change it to get

P1F3: alright for my self, (you know) it is enjoyable but (you know) I do not know sometimes may be if you got features …. So it depends how it looks ….The things is I want to try the clothes on not on a virtual model.
Researcher: did you enjoy it
P1F3: for me I don't enjoy it.
P2F3: for me if I have a website like this I will leave the website to buy my clothes and I would not to be delivered
P6F3: (due to bad recording, this part has been revised by the owner of this voice to make sure what he said).
It depends on the opportunity at ones disposal that one shop online how the individual interaction reacts to the use of the computer. However, people irrespective of seeing the product online still wants to touch the product (physically feel) before buying decision is made. In my case I am always facing a problem with the shirt sleeves. i.e. if I decided to buy a t-shirt online then I face

difficulties in getting the right product sleeves. My arm length (my measurement) is not right all the time. So using 3D virtual model would make several problems. On the other hand, when I go to an offline retailer and when I did not find a proper size, I am all the time, taking an extra size to suit my long sleeves. Yet, it might be bigger to my body. Buying online is (3D) is limited to an extent since you are not interacting with an individual (salesman), the computer is programmed and it is working accordingly. Even though the shop can be stressful but it is comfortable for me.

I prefer going to offline shop to buy for other reason; money, when you go to an offline retailer and you show the salesman your money there is an opportunity to have certain discounts.

Researcher: does surfing this site give more information or sense of fun:

Ya

Yes,

And I think, More interacting, more feel of the product. You can change it easily

Researcher: Lets go and see the last site; it is a make up site, again surf the site for couple of mints, you can (in this site) up load your picture here and then…..

Ya,

I want you to tell me how do you feel and think about this site?

P1F3: I think you should target female population

P2F3: I am not going to buy it.

P6F3: for me its just playing around.

P3F3: it more fun.

P2F3: I think for girl. If they up load their picture, I think really good.

Researcher: Do you believe in such colours you can see here

P3F3: Me

Researcher: yes.

P3F3: no. they are different.

Researcher: so you think that girls prefer going to an offline retailer to by such make up.

P3F3: I am not going to buy it online; especially I do not know the brand of this make up.

Researcher: If you have a well known brand here

P1F3: I think (you know) for example, laptop has feature, people have the features they are not like make up if you don't feel the colour properly or maybe the clothes I don't know (I know) may be you have an clue or whatever or you don't expected it that way. In a lap top (you know) you have got features you can check the colour but in clothes using 3d is not like real life (you know).
Must: for ladies make up what you find you will feel. Rather than buy a laptop and this is much visible for the colour, you can see the colour you can see what ever, but that is the feel you have maybe here does it click you can may be you,,, one again you can look up to this can look save the picture of the face and can use 3D to see the colour. But You may be not buy unless you go and see the product.

Researcher: the last thing is to ask you about your responses; after surfing the three sites laptop, my virtual model and the make up sites. Do you have any intensions to buy from theses sites. Lets say surfing the lap top you see the features from Dell and Sony, do you have the intensions to buy the product or I like it I might buy it.
P1F3: for the lap top I might but for the clothes and make up no.
P2F3: for me clothes yes, but the lap top no, I have to again and see in an offline retailer.
P6F3: The lap top yes. The make up I an buy, because if I up load the picture, I can as a gift.
Lao: for me clothes.
P3F3: when it comes to low involvement I will buy any product in 3D but with high involvement product.

Researcher: do you think that using 3D will increase your patronizing an offline retailer, seeing the product online and then go and see it offline.
It dependes on the product (high and low involvement)
The first case is: seeing the product online and then say I still have this feeling of going back to the offline retailer to make sure that every think is okay.

P1F3: what I need I want to the brand I want to go and buy it. If I go the shop Addids and nike pick up the staff and go home (you know) instead of (you know) go to an offline shop you spent time and then you want to different shops, but if you know the brand you might go to different shop just to check the prices. But you know what you want.

What a bout perceived risk, using such 3D or virtual model, do you think might reduce your perceived risk?

What do you mean by perceived risk?

Any risk you might think about (performance, money).

P1F3: Clothes the quality the risk is taken for clothes but I will not take it for a laptop (its standard).

If you have two options saying the product in static pictures or 3D what would you choose?

3D, of course 3D.

But there is no 3D in the make up?

Researcher: Yes, this is kind of interactivity; it is related to interactivity more than 3D. Apart of this, we are speaking about using 3D, is the static picture you need to see all pictures read all the information or seeing in 3D?

P3F3: when it comes to this I prefer using 3D.

Baiscally, may electrical retailers are not using 3D, except for international companies like Dell Soney (world wild), some times when you are planning to buy a digital camera or an ipod or what ever. Do you think this (3D) may help in making your purchase decision?

P3F3: I prefer going to an offline retailer.

Researcher: even if you go directly to the offline retailer you are not allow to sometimes to play with the product as you like.

Assuming that i will not tie it in both dream ya I like, it comes to the money, if I am paying certain amount say 200 pounds, I would like to go and see it by my self, just to feel more secure about since I am paying a lot amount of money, in the case camera of 90-80 pounds it is enough to see it online matching it with other product, and I can buy it online I have no problem. Again it comes to the money.

P2F3: say if you have a doctor online and you can send him symptoms and say I have these problems and he said oh you have this go and take this medicine and

will send you say an email with his signature say go and buy, would I do that? Assume it happens like a clinical interacting (in a way) but it's a teaching things more than diagnostic? I am talking a bout the basic diseases?
Researcher: let us go back to the main point?
Researcher: are you going to tell a friend about this experiment, word of mouse? Are sending an email, telling others about.
Ya for the make up ya I think I will
I would like to do
Word of mouse (sending an email to your friend)?
Ya I think I would like to tell
I would tell unless some one asked me.
P6F3: if you do it several times then you will be an advocate ………………………………..
People usually speak about this, they said Ivery cheap
I got a pizza online and I told every body (just order it)
Adel: If enjoyed something you had fun and what you expected you had received or what ever, then you will tell people, I mean exactly I have another friend who bought very (very) cheap pizza he told about his experience online. Now online retailers are established
It is a question of people are trusting buying online (save and every thing), so now it's a company that looking to provide more attractive features to people, to convince people how to….. you know offline retailers they hair nice girls (or whatever) and in online they provide sweet people…..

P6F3: exactly or pure online seller, it would be more powerful for offline or multichannel seller.
P1F3: make them more truthful.
P2F3: you would not be distracted by the place and walking in the place, you just see the product and only the product.
Researcher: Do you think surfing any of these site giving the feelings like dealing with a seals man so you telling the salesman I need this colour, I need you to this I need you to do that?

P1F3: ya, better than the salesman, like I said I don't want to be distracted if you want to sell every product here just giving you the product and its features with out going in details trying to sale it to me. (of course)

P6F3: I think the advantage of going to shop is to acquire, If the sales had the impression to interact with you to move around in order to get your desired item, its may create a wrong impression a bout the organisation and about such a shop and even the desire (or whatever) may be off. But online, all the information about such product is there, you do not have to choose how you going satisfy such a desire and the end of the day a few link you can take online. But the influence of the 3D within the interactivity of 3D is that it creates that case. The only thing you can have is that feeling of creates the old condition now how of shop. The opportunity of acquiring and feeling not in real, that problem is second.

That's it thanks………………..

Focus group 4

Researcher: Good afternoon every one, in this section we are going to discuss the main elements of a 3D product visualisation and virtual experience. In front of you, you will have two sites; one of them has a real product the other one has an external devices that users used to have to live a fictitious life. Please, for 4 minutes, surf each site.

Researcher: what are the main elements that could be relied on to define a real virtual experience?

P1F4: Well, I think that my ability to see the product with different colours, enhances my experience.

P2F4: My ability to zoom in out the 3D makes me feel that Just I am in an online retailer.

P3F4: The 3D seems real, I mean it looks like I am holding a real product and playing with it.

R4F4: the experience I am having in this site reminds me of having a direct purchase from a salesman, I am just asking for different colour, and I am getting it directly.

P1F4: Yes, that right.

P5F4: this is so nice, in the 3D model, what ever you asked for, you can get easily. I mean if you click on certain parts, you will have more information about the characteristics of the laptop.

Researcher: I would like to discuss two construct with you; telepresence and authenticity. Previous researchers within the online retailers have focused their efforts on the telepresence construct to explain the VE. First of all, telepresence is a construct that have been evolved and established on the area of non-immersive VR. Please see the pictures and the video that might give you more information about this notion (you have five minutes to do this).

Researcher: What do you think of the video and the picture?

R1F4: I felt that I am not living in a real life; this kind of technology is like escapism from the real world.

P2F4: The technological devices that the people are having let me feel that they are trying to be in a different world.

P3F5: I think the technology here is so advanced to the moment I felt that it is like playing a game using the WI technology.

Researcher: go now to the 3D laptop site and tell me what is the difference between the two construct (you have five minutes to see them).

Researcher: Please, I want you to explain the main differences between the two virtual experiences (if you are using both of them).

P4F4: I like the telepresence experience because it let you travel to other places while your body is in the room. However, if I want to have a very similar experience to what I can find in the high street product I prefer using the 3D products case.

P2F4: Ya, in the 3D laptop case I can see a real product but in the external device case I felt it is like fun but not real.

P3F4: Both experiences were nice, but I think I can buy product from the 3D. However, I can not from the other site.

Researcher: I will give you a paper in which you will find a scale for measuring the telepresence scale. After reading the scale I want you to tell me if we can use such a scale to measure our VE in the case of using the 3D product visualisation (please take a five minutes to read and understand the scale).

Researcher: Any comments?

P1F4: Well, I think the use of the word immersion makes me feel that the 3D product is not a real product, because I can see and find such a product in the high street retailer.

P2F4: I would say that the phrase being there or being transported into author areas is absolutely, totally, unacceptable (for me), because I did not feel that I have separated my body from my mind.

P4F4: I hated the phrase “I forget that I was in the middle of an experiment”, because I did not, It was a normal experience; I mean it was not that “WAW”.

P3F4: The phrase “I felt that I came back to the real world after a journey”, irritates me, because I would not describe my experience with this phrase.

P1F4: Yes, I think this scale may not represent my own real VE.

Researcher: Using the 3D product visualisation (you are seeing at the moment), what elements do you think should be used to measure consumers’ virtual experience in this context.

P2F4: I think we should use words and phrases that can reflect the reality of this product. i.e., we should emphasis on the realism of the product and what makes such product experience similar to the offline experience.

P3F4: Yes, I think we should focus on the consumers’ ability to rotate, zoom in or out on the product. In other words, we can assume that we are in the offline retailer where we can touch the product and roll it, rotate it.

P4F4: I think we should also focus on the ability of the users to change the colour of the laptop. I mean this is so similar to the offline experience when you ask the salesman to give you another colour of the product.

P3F4: we can focus on the 3D ability to enhance the feeling of seeing the laptop as it is a real one sensory way.

P5F4: we should focus on the fact that the 3D is giving the navigators more info. about the product, and the colour.

P2F4: Yes, I do agree we need to focus more on the sensory aspects of the 3D, because we are speaking about a psychological state more than any thing els.

That’s it thanks………………..

Appendix 9:

PUBLISHED JOURNAL PAPERS

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Using Authentic 3D Product Visualisation for an Electrical Online Retailer

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Abstract

This study aims to investigate the effects of authentic three-dimensional (3D) product visualisation on consumers' virtual experience (VE). Particularly, we define and operationalise virtual experience based on three elements: control, animated colours and 3D product authenticity. Moreover, we investigate the effects of control and animated colours on the creation of the 3D product authenticity factor, which in turn impacts consumers' experiential and instrumental values. A hypothetical retailer website presents a variety of laptops that allow the participants to control the content and form of the 3D flash. The 3D flash permits the participants to change the colour of the laptop and see it in their chosen colour. Also it allows them to get information about the laptop features and attributes. We find that control, animated colours and 3D product authenticity represent the main elements of the virtual experience. Moreover, control and animated colours represent the main antecedents of 3D product authenticity. Also, experiential and instrumental values represent the main consequences of 3D product authenticity.

-Key words: Control, animated colours, telepresence, 3D product authenticity, values, virtual experience.

INTRODUCTION

The importance of non-store retailing appears to be well founded in the retailing industry. The Image Marketing Retailer Group's (IMRG 2008) Capgemini e-Retail Sales Index shows that online electronics and clothing are among U.K. shoppers' favourite purchases, with 38 per cent and 32 per cent share of revenues, respectively. Moreover, the non-store retailing industry is expected to grow steadily and to play an essential role in the retail industry (IMRG 2008). Furthermore, many non-store retailing companies already claim to have improved their sales as a result of designing and using three-dimensional (3D) flashes. For example, J.C. Penny, eBags and Wal-Mart claimed that their online sales have increased 10 per cent to 50 per cent after using rich media, such as 3D flashes (Demery 2003). Moreover, Demery (2006) posits that the number of companies that are investing in 3D virtual models is increasing steadily because these companies are seeing the potential of the technology for selling more products and improving the consumers' virtual experience (VE) (Li, Daugherty, and Biocca 2001). VE derives from virtual reality (VR) and can be defined as "*psychological and emotional states that consumers undergo while interacting with a 3D environment*" (Li et al. 2001, p. 14). A 3D presentation enables the consumers to interact with products, enriches their learning processes, and creates a sense of being in a simulated real world. Furthermore, direct and virtual experiences combine within VR, such that the latter enhances and enriches the overall experience because consumers use almost all of their senses when interacting with a 3D product visualisation (Klein 2003; Li et al. 2001, 2002, 2003). Despite widespread discussions and various definitions of VE, we notice that previous scholars, within the online retail context, consider interactivity, vividness and telepresence (or presence) constructs to be at the centre of defining and operationalising consumers' VE. Furthermore, we notice that there is still some debate regarding not only identifying the main antecedents of VE, but also defining and operationalising telepresence and presence constructs. Based on this, we claim that for VE to psychologically surpass an actual experience with the offline products, telepresence and presence constructs should not be used to represent the VE, because they present a process of being mentally transported into other areas or being immersed in an environment of illusion. Such notions may not be particularly helpful for marketers and website designers who are concerned with 3D product visualisation of real products. Instead, to define and conceptualise VE in the non-store retailer environment, we propose three elements: control, animated colours and 3D product authenticity (which refers to simulating a real product authentically online) constructs. We therefore first discuss the main categorisations of VE (based on telepresence or presence constructs) and their antecedents in the immersive virtual reality (IVR) environment, then proceed to explain the applications of non-immersive virtual realities (NIVR) in the non-store retailer context. To explain VE for the online retailer, we offer a new definition and measurement scale for the construct of 3D product authenticity, its antecedents and consequences, focusing on a fictitious electronics retailer, which offers laptops as the focal product. Finally, we develop and test a structural model (Figure 1), proposing relationships between control, animated colours, 3D product authenticity and consumer value variables.

THEORETICAL BACKGROUND

3D Virtual Experience in Immersive Virtual Realities

The first appearance of VR terminologies started with the emergence of IVR devices, such as head-mounted displays, which allow users to interact with virtual environments and to visualise different objects (Suh and Lee 2005). As a result, previous scholars in the IVR field define and operationalise VE based on two categories: the notions of telepresence and presence. For example, Steuer's (1992, p. 76) definition of VR focuses on the human experience, not technological hardware, and differentiates between two types of VE: presence and telepresence. Whereas presence refers to "*the experience of one's physical environment; it refers not to one's surroundings as they exist in the physical world, but to the perception of those surroundings as mediated by both automatic and controlled mental processes*", telepresence is "*the experience of presence in an environment by means of a communication medium*". In turn, Sheridan (1992) distinguishes between presence and telepresence, such that presence relates to the simulated perception of direct experience (i.e., a sense of being in a computer-mediated environment), whereas telepresence indicates the direct experience of reality (i.e., a sense of being in any real remote location). However, Biocca (1992) defines VE (based on the telepresence construct) as the users' ability to be psychologically transported into another area. To that end, Biocca and Delaney (1995) argue that the definition of virtual reality experience depends on technological hardware and software. The authors define VE as perceptual immersion. This type of VE depends on sensory immersion in virtual environments. To extend prior literature, Lombard and Ditton (1997) identify six taxonomies of VE: social richness, realism, transportation, immersion, social actors within a medium and media as social actors.

Previous IVR research on the 3D virtual reality experience (e.g., Biocca 1997; Heeter 1992; Lombard and Ditton 1997; Sheridan 1992) thus reveals several key findings. First, the researchers from different fields (e.g., communication, business, psychology, and human-computer interaction) use different terms (e.g., presence, telepresence, virtual presence, immersion, mediated presence) to define and conceptualise users' VE. However, there is still some debate regarding the basis of defining VE (i.e., whether it is a state of presence or telepresence). Second, previous research uses presence and telepresence to explain VE, though these conceptualisations have depended on the level of technology (e.g., Biocca 1992; Steuer 1992; Sheridan 1992). Whereas in the past researchers used display interface technologies such as goggles, head-mounted visors, data gloves, joysticks, head trackers and televisions to identify and measure VR experiences (e.g., Biocca 1992; Heeter 1992; Lombard and Ditton 1997; Sheridan 1992; Steuer 1992; Witmer and Singer 1998), more recent technological developments can "transport" users to other places, where they can see and interact with other intelligent beings (e.g., avatars in Second Life, chat rooms, online communities), without forcing them to wear technological devices. To explain this issue, Lombard and Ditton (1997) posit that the main reason for using different VR experience terminologies, such as presence or telepresence, is to simulate a virtual environment that users cannot experience in real life. For example, some virtual environments are created to increase the users' fantasies of being transported into a life in which they wish to control, others so as to decrease the dangers of real life aspects: i.e. in the case of military or space shuttles. Finally, some virtual environments are designed to treat people with diseases, such as phobias.

To identify the main determinants of VE within IVR, researchers follow interactivity and vividness theories. For example, previous scholars (Biocca and Delany 1995; Heeter 1992; Lombard and Ditton 1997; Sheridan 1992; Steuer 1992; Witmer and Singer 1998) assert that interactivity and vividness may represent the main antecedents of a 3D virtual reality experience. Interactivity appears to be of particular interest since the appearance of new communication channels, such as the internet, for which it represents a critical concept and primary advantage (Morris and Ogan 1996; Rafaeli and Sudweeks 1997). Considerable research investigates and empirically tests the construct, but there is little agreement on the definition or operationalisation of the interactivity factor (e.g., Ariely 2000; Klein 2003; Liu and Shrum 2002; McMillan and Hwang 2002). For example, Steuer (1992) deconstructs it into three elements: speed, mapping and range. Rafaeli (1988) and Rafaeli and Sudweeks (1997) argue interactivity relates to the communication process, and Ariely (2000) defines it on the basis of the control construct (the narrowest definition). Wu (1999) relies on the self-efficacy construct, whereas Rowley (2008) focuses on information interactivity. Still other scholars (e.g., Downes and McMillan 2000; Lui and Shrum 2002; McMillan 2002; McMillan and Hwang 2002) argue that definitions of interactivity cannot be restricted to messages, human interactions or communications, but rather should include multidimensional aspects. Thus, speed, responsiveness and communications represent the main elements that define and measure the interactivity factor. In contrast, vividness, according to Steuer (1992, p. 81), is "*the way in which an environment presents information to the senses*". Steuer explains that vividness is stimulus driven and depends completely on the technical characteristics of a medium. In turn, it represents a product of two important variables: sensory breadth and sensory depth. Most scholars use this definition of vividness.

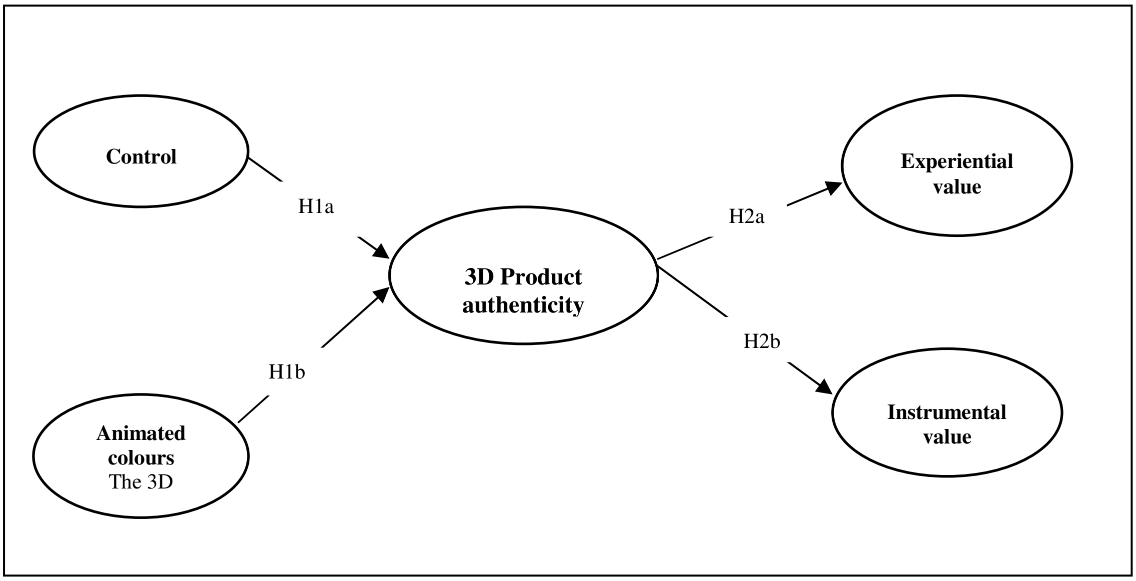
3D Virtual Experience in Non-Store Retailing

To address the issue of using external devices, online retail literature introduces the NIVR environment, which allows users to interact with e-retailer websites and products by using 3D product visualisations in desktop or laptop computers (Suh and Lee 2005). Furthermore, retail literature defines and operationalises VE based on three elements: interactivity and vividness of the 3D product visualisation, and the notion of telepresence. Notwithstanding Lombard and Ditton's (1997) classification of VE, only two types are identified in the non-store retailing environment. The first is VE as telepresence, or the illusion of being in a place far from the physical body (based on Biocca 1997; Heeter 1992). This conceptualisation of VE relates to transporting a user, self, or place to another place. The second form is VE as a social telepresence, such that other beings exist in the VR world with whom users can interact (e.g., avatars). Authors such as Heeter (1992) and Lombard and Ditton (1997) empirically test this concept, and McGoldrick, Keeling and Beatty (2008) emphasise the avatar's role in enhancing virtual personal shopper capabilities.

To conceptualise consumer experiences in cyberspace, scholars within the online retail literature have empirically tested the influence of 3D on consumers' virtual experiences. For example, Shih (1998) posits that the vividness of the information (operationalised as multi-sensory information, i.e. breadth and depth) that a consumer receives in cyberspace and the interactivity of the cyberspace technology (operationalised as control, speed and feedback) provide the main antecedents of VE (i.e., being there or telepresence). In turn, Coyle and Thorson (2001) investigate the effects of progressive levels of interactivity and vividness on web marketing sites by manipulating the levels of interactivity (number of choices and presence of a clickable image) and vividness (audio and animation). They find that high levels of interactivity and vividness increase the participants' feelings of VE (i.e., being there or telepresence). Fortin and Dholakia's (2005) empirical research reveals the direct and indirect impacts of interactivity (degree of control, response time) and vividness (breadth and depth of the message, colours, graphics, quality and resolution) on social VE (i.e., presence, or being there). High levels of interactivity and vividness have significant impacts on perceived VE (i.e., social presence). According to Klein (2003), Macromedia represents simple technology and thus provides another means to examine the effects of VE (i.e., telepresence, being transported to another area) on consumer responses. Moreover, Klein (2003) finds that interactivity (user control) and media richness (depth and breadth of sensory channels) emerge as the main antecedents of consumers' VE (telepresence), with significant positive influences on telepresence creation. To that end, Lee (2004) revises all the previous definitions of telepresence or presence and argues that none of the previous definitions can be used to illustrate the concept of using the virtual environment to reflect consumers' VE. The author posits two ways for an experience to become virtual: first, by using "para-authentic objects" in which the users interact with objects they can find in real life, such as clothing; secondly, by using "artificial objects" that simulate objects that do not exist in real life. On that basis, we claim that using the notions of 3D telepresence or presence and their definitions to define VE neither help marketers and e-retailers to understand the effect of 3D product visualisation on consumers' VE, nor suit the online retail context. Because these terminologies (i) were based on using external devices, such as head-mounted display and (ii) often connote negative meanings, such as immersion, delusion and transportation (Lee 2004), we propose the notion of 3D authenticity and its antecedents (control and animated colours), reflecting the authentic representation of VE. A 3D virtual experience should be an authentic representation of the direct (offline) experience. The concept of 3D authenticity of the product visualisation implies the ability of the 3D technology to simulate the product experience in a "bricks-and-clicks" context. We propose the following definition of 3D product authenticity in a computer-mediated environment: 3D product authenticity is a *psychological state in which virtual objects presented in 3D in a computer-mediated environment are perceived as actual objects*. Furthermore, we identify users' ability to control the content and form of the 3D flash (interactivity), animated colours (vividness) and 3D product authenticity as the main elements of the VE. Moreover, we define control and animated colours as the main antecedences of 3D product authenticity.

To identify the main consequences of using authentic 3D product visualisations, and to explain cognitive and emotional experiences that consumers may have from navigating an authentic 3D product visualisation, we follow the experiential and instrumental value theories (based on Babin, William and Griffin 1994; Fiore, Kim and Lee 2005a). Scholars (e.g., Fiore and Jin 2003; Fiore et al. 2005a; Kim, Fiore and Lee 2007; Klein 2003; Li et al. 2001, 2002, 2003; Suh and Chang 2006) assert the ability of authentic 3D product visualisations to produce instrumental values, which often enhance consumer understanding of product attributes, features and characteristics. An authentic 3D product visualisation increases consumer involvement and encourages them to seek more information about the products (Fiore et al. 2005a). Suh and Lee (2005) posit a positive relationship between higher levels of 3D product visualisation and seeking more information about the product's characteristics and features. Suh and Chang's (2006) empirical research on the influence of authentic (real) 3D product visualisation on product knowledge reveals a positive relationship between 3D and perceived product knowledge. Using an authentic 3D product visualisation helps the consumers to imagine how a product may look and gives them more details about the product's characteristics (Fortin and Dholakia 2005; Klein 2003; Shih 1998). On the other hand, scholars (Fiore, Jin and Kim 2005b; Kim and Forsythe 2007; Lee, Fiore and Kim 2006; Schlosser 2003) report the importance of 3D product visualisation in enhancing the experiential aspects of virtual shopping. Previous scholarly literature finds the ability of an authentic 3D product visualisation to produce greater experiential value than instrumental value for shoppers. For example, Fiore et al. (2005b) assert experiential value, which 3D image interactivity technology produces, is highly correlated with consumers' emotional pleasure and arousal variables. Fiore et al. (2005a) posit the importance of 3D virtual models in boosting experiential value (enjoyment). Fiore et al. (2005a) report the importance of a high level of 3D image interactivity technology in producing more experiential value. Many scholars in the communication field (e.g., Heeter 1992; Lombard and Ditton 1997; Song, Fiore and Park 2007) report the importance of enjoyment as a consequence of using an authentic 3D product visualisation. The consumers use 3D product visualisation to have more entertainment (Kim and Forsythe 2007). Such sources of fun or enjoyment come from the consumers' ability to rotate, and zoom in or out on, the product (Fiore and Jin 2003), seeing different animated, coloured, pictorial images that may enhance their mental pleasure when using 3D sites. Figure 1 shows the main antecedents and consequences of the 3D product authenticity factor in this study.

Figure 1: conceptual framework (source: the authors).



3D Product Authenticity Antecedents

We use the control construct to represent interactivity in an online retail context. Ariely's (2000) definition of control refers to the users' abilities to customise and choose website content to achieve their goals. We focus more on consumers' ability to control and easily interact with the 3D virtual model. Therefore, we define control as *user ability to choose the content and form of the 3D virtual model, particularly: the ability to rotate and zoom in or out on the product, and to click on any part of the 3D virtual model to get instant information about it; and the ability of the 3D virtual model to properly respond to the participant's orders.* In turn, we hypothesise:

> *H1a: The degree of user control of a 3D product visualisation affects the perceived authenticity of the 3D product visualisation.*

Some 3D product visualisations in the online retailer environment require visual and auditory channels for facilitating consumers' vividness; others need only visual aspects. We focus on one aspect of vividness, namely, breadth, while holding depth constant. Specifically, we focus on one aspect of vividness breadth, namely, animated colours. Animated and coloured pictorial images are used in this study to represent the consumer's ability to see 3D products with different animated skins, just as the consumer would see them in person. High-quality, online, animated colours may enhance the consumer's perception of the authenticity of the 3D product visualisation (e.g., Fortin and Dholakia 2005; Klein 2003; Shih 1998). Animated colours (media richness) may lead to a true VE, according to research on online shopping (Klein 2003; Schlosser 2003), and therefore:

> *H1b: User control of animated colours increases 3D product authenticity.*

Effects of 3D Product Authenticity

We use experiential and instrumental values to represent 3D product authenticity consequences. We follow Babin's et al. (1994) definition of experiential value to reflect shopping's potential entertainment and emotional worth. However, instrumental value refers to the ability of the 3D product visualisation to reflect shopping with a work mentality. Scholars (Fiore et al. 2005b; Kim et al. 2007; Kim and Forsythe 2007; Lee et al. 2006) report the importance of authentic 3D virtual models for enhancement of a consumer's experiential and instrumental experience. Based on the above, we hypothesise:

> *H2a: 3D product authenticity in a retailer website will positively affect website use for experiential value.*

> *H2b: 3D product authenticity in a retailer website will positively affect website use for instrumental value.*

METHODS

Stimuli

A retailer's website with one stimulus was custom-designed for this study. The stimulus was illustrated as a 3D product visualisation, in which participants can see the focal products, laptops, from different angles, i.e., they can rotate and zoom in or out on the product. The 3D stimulus is designed to help consumers imagine the product in appropriate and relevant ways, and it enhances consumers' virtual experiences (Li et al. 2001).

Interface Design

We designed one stimulus, a 3D flash (site), for testing the proposed hypotheses. The site allows participants to control the content and form of the 3D flash. For example, the participants can zoom in or out on the product, rotate it and see different parts of the product when clicking on it. The 3D flash permits the participants to change the colour of the laptop and see it with their chosen colour.

Also the flash allows the participants to get information about the laptop features and attributes. Moreover, our site enhances participants' fun and enjoyment values by enabling them to control visualisation (i.e., to zoom in or out on and rotate), to change the colour of the laptop and to see more information about the product (see Appendix A). In designing this interface, we considered a comprehensive site for visualising an online electronics retailer to be one that surpasses an actual experience. Moreover, this study adds more features and cases to the ones that might be found in real sites. For example, none of the national sites that sell laptops (e.g., Sony and Dell, to the best of the authors' knowledge) has a flash combining both 3D and information about laptops. The website we created for this study was not previously known to users, nor did users have any knowledge of the fictitious brands on the site. Thus, we eliminated any impact of previous experiences or attitudes (Fiore et al. 2005a). The site offers a wide variety of laptops, similar to those that many college-aged women and men currently buy and use. Therefore, the site provides a suitable context for the present sample.

Sample

Student samples have often been used in online shopping research (e.g., Balabanis and Reynolds 2001; Fiore et al. 2005a; Kim et al. 2007; Li et al. 2002, 2003). This is justifiable as students are computer-literate and have few problems in using new technology. Students also are likely consumers of electronic goods (Jahng, Jain and Ramamurthy 2000). We used a sample of 312 students for the data collection. The sample was gender-balanced, consisting of 47% women and 53% men, and 90% of the sample ranged from 18 to 30 years of age. Approximately 94% reported having had prior online shopping experience. We conducted a non-response bias test (Armstrong and Overton 1977) to confirm the generalisation of our results, via comparison of the late responses with the early responses. The results show no significant difference between respondents ($p >$ 0.05, regarding control, animated colours, 3D product authenticity and values). As a result, a non-response bias was not considered to be a serious limitation in this study.

Time

Time exposure to a stimulus influences user end responses (Zajonc 2001), so several studies attempt to determine the appropriate time exposure to an online stimulus (e.g., Fiore and Jin 2003; Fiore et al. 2005a; Kim et al. 2007). We followed these studies and set a time limit of five minutes to navigate our stimulus. After viewing the stimulus for the allotted time, the subjects completed a questionnaire. To check the common method bias, we followed Harman's single-factor test, confirmatory factor analysis (CFA), and multitrait-multimethod (MTMM, Podsakoff et al. 2003) techniques. The results show that common method variance is not of great concern and thus is unlikely to confound the interpretations of our results.

OPERATIONALISATION

The participants were informed that this study pertained to consumer evaluations of an electronics retailer's website. The questionnaire contained five-point Likert-type scales, anchored by "strongly disagree" and "strongly agree".

To measure the control construct, we developed a five-item scale that centres on the user's ability to rotate and zoom in or out on the virtual model, based on McMillan and Hwang's (2002) and Song and Zinkhan's (2008) studies. To measure animated colours, we developed a four-item, animated colour scale, based on Fiore et al. (2005a), Klein's (2003) and Steuer's (1992) studies. The items measure how closely the simulated sensory information reflects the real product. We could not find an existing scale to measure 3D product authenticity, so we followed Churchill's (1979) procedures for developing a marketing scale. We developed a new five-item scale and submitted it for evaluation by academics (lecturers in online retailing and Ph.D. students); these respondents considered the items relevant for measuring the 3D product authenticity construct. Each item began with "After surfing the 3D sites", and then obtained responses to the following: "3D creates a product experience similar to the one I would have when shopping in a store", "3D let me feel like if I am holding a real laptop and rotating it" (i.e. virtual affordance), "3D let me feel like I am dealing with a salesman who is responding to my orders", "3D let me see the laptop as if

it was a real one", and "Being able to zoom in/out and rotate the laptop let me visualise how the laptop might look in an offline retailer".
To measure experiential values, we adopted a modified version of Babin et al's. (1994) scale. We based the study on 4 of the 11 items. To measure instrumental values, we adopted a modified version of Fiore et al's. (2005a) scale. See Table 1 for the refined items.

Pre-tests

We ran a series of pre-test to develop the study materials. Respondents (n = 30) were asked to rate several 3D flashes based on their controllability and colourability dimensions (5-point scales). Manipulation checks were used to decide if the participants had noticed the differences between the various conditions of each construct. For controllability, the participants explored a 3D flash that they could control by zooming in and out and rotating; they also explored a 3D flash that zoomed in and out and rotated on its own, which they could not control. After each level they were shown the following question: "To what extent do you consider that the 3D flash is controllable?" For animated colours, the participants explored a 3D site where they could see different colours of the same laptop, as well as a 3D site where they could see the laptop only in a single colour. After each level they were shown the following question: "To what extent do you consider that the 3D site is colourful?" The results confirmed that participants noticed the different levels of each construct. They perceived that the 3D website that they could zoom in or out and rotate as being significantly more controllable than the 3D website where they had no control of the zoom and rotation ($M_{\text{high control}} = 15.9$, $M_{\text{low control}} = 9.5$; $F_{1, 29} = 116.4$, $p < .001$). Moreover, they perceived the website with more colours as significantly more colourful than the website with one colour ($M_{\text{high animated colours}} = 11$, $M_{\text{low animated colours}} = 6.4$; $F_{1, 29} = 45.43$, $p < .001$).

RESULTS

Measurement Model

AMOS 16 was used to test the overall goodness of fit of the conceptual model, using 312 participants. The measurement model includes 19 indicators, and we provide it's results in Table 1, including the standardised factor loading (λ), standard error (SE), critical ratio (CR), average variance extracted and composite reliability for each construct. Cronbach alpha reliabilities for animated colours (.747), control (.805), 3D product authenticity (.871), experiential value (.856), and instrumental value (.858) all are acceptable (Hair et al. 1998). Figure 2 illustrates path coefficients and the coefficient of determination (R^2) for the effects of control, animated colours and 3D product authenticity on values; all the paths are valid. Moreover, average variance extracted by each construct exceeds the minimum value recommended by Hair et al. (1998) (i.e., 0.5 or above), indicating convergent validity. The square roots of the average variance extracted by each construct exceed the correlation between them (Table 2), demonstrating discriminant validity. Thus, our instrument had a satisfactory construct validity (Anderson and Gerbing 1988; Fornell and Larker 1981).

Figure 2: Structural path coefficients and R^2 for the effects of control, animated colours and 3D authenticity on values.

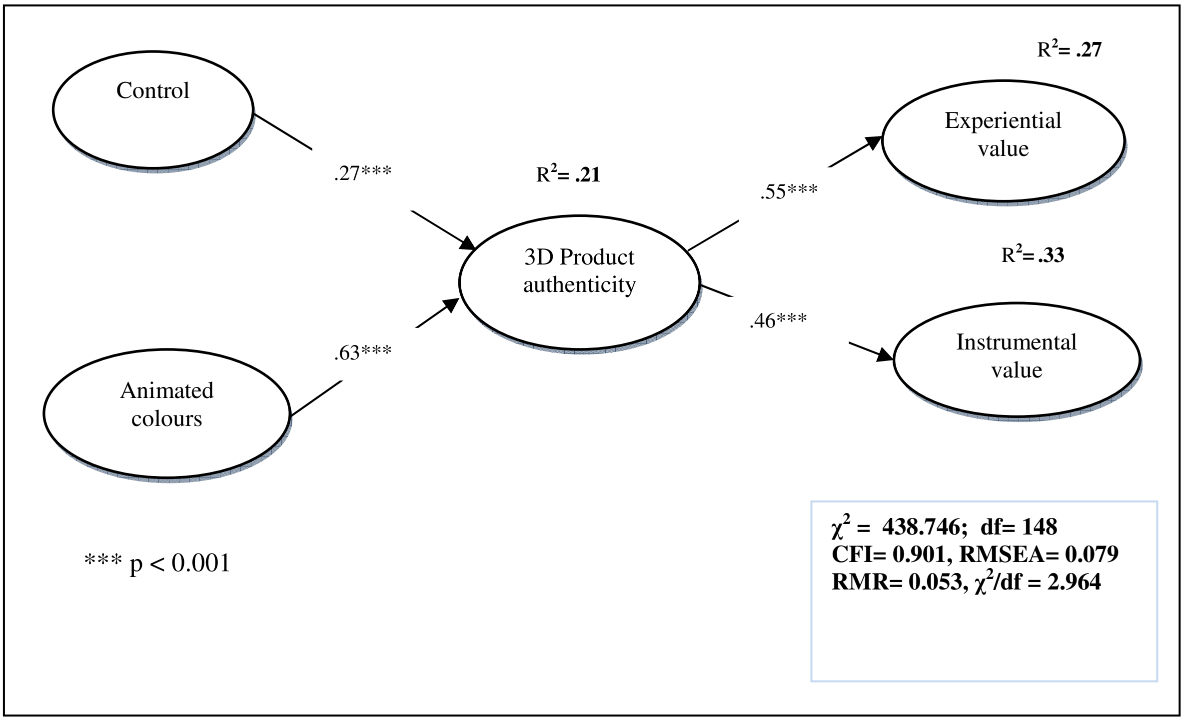


Table 1: Measurement model results for a hypothetical model with new factor structures.

Construct indicator	Standardised factor loading(λ)	SE	CR	Average variance extracted	Squared multiple correlation	Composite reliability
η 1 (control) - I felt that I could choose freely what I wanted to see. - I felt that I had a lot of control over the content of the laptop's options (i.e. angles and information). - I felt it was easy to rotate the laptop the way I wanted. - I felt I could control the laptop movements.	.775 .742 .693 .593	- 0.080 0.079 0.073	 12.165 9.537 8.471	0.50	0.352 0.480 0.550 0.601	0.80
η 2 (animated colours) -There are lots of colours on 3D laptop websites. - Colours brightness of the 3D laptop let me visualize how the real laptop might look. - The laptop illustrated by 3D was very colourful.	.721 .606 .785	- 0.75 0.067	 10.551 9.589	0.50	0.367 0.520 0.616	0.75
η3 (Authenticity) - 3D Creates a product experience similar to the one I would have when shopping in a store. - 3D Let me feel like if I am holding a real laptop and rotating it (i.e. virtual affordance). - 3D Let me feel like I am dealing with a salesman who is responding to my orders. - 3D let me see the laptop as if it was a real one.	.780 .760 .771 .781	- 0.077 0.080 0.077	 13.839 15.498 14.589	0.612	0.626 0.719 0.552 0.551	.86
η4 (Experiential value) - Would be like an escape. - Would be truly enjoyable. - Would be enjoyable for its own sake, not just for the items I may purchase. - Would let me enjoy being immersed in an existing new product.	.696 .732 .816 .816	- 0.076 0.090 0.090	 12.107 12.740 12.677	0.588	0.666 0.666 0.535 0.485	0.85
η5 (instrumental value) - Help me make a better decision about the product. - Help me buy the right product. - Aid me in evaluating the laptop items. - Help me in finding what I am looking for.	.780 .760 .771 .781	- 0.062 0.066 0.072	 13.743 12.863 13.226	0.597	0.609 0.595 0.578 0.609	0.86

Table 2. Discriminant Validity

Construct	Animated Colours	Control	3D Product authenticity	Experiential value	Instrumental value
Animated Colours	**.707**				
Control	.459(**)	**.707**			
3D Product authenticity	.633(**)	.475(**)	**.782**		
Experiential value	.487(**)	.309(**)	.568(**)	**.766**	
Instrumental value	.381(**)	.321(**)	.422(**)	.446(**)	**0.772**

(**) ***p*< 0.01. The figures under the diagonal are the Pearson (R) correlations between the variables. Diagonal elements are square roots of average variance extracted.**

Structural Equation Model

The adequacy of the hypotheses was assessed by using the comparative fit index (CFI), root mean square residual (RMR), goodness of fit index (GFI) and root mean square error of approximation (RMSEA) to test the overall goodness of fit of the proposed conceptual model. The results of structural equation modelling obtained for the proposed conceptual model revealed a chi-square of 438.746 (df = 148), CFI of .901, RMR of .053, GFI of .90 and RMSEA of .079, indicating a good model fit (Byrne 2001; Hair et al. 1998). All hypotheses of the conceptual model were statistically supported (p < .001). Figure 2 shows that control and animated colours are significantly associated with 3D product authenticity (H_{1a}: CR = 4.422; H_{1b}: CR= 8.844). Moreover, as hypothesised, 3D product authenticity is significantly associated with experiential and instrumental values (H_{2a}: CR = 8.852; H_{2b}: CR = 7.533).

DISCUSSION, CONCLUSION AND IMPLICATIONS

This study aims to investigate the effects of authentic 3D product visualisation on consumers' VE. Particularly, we define and operationalise VE based on three elements: control, animated colours and 3D product authenticity. Moreover, we investigate the effects of 3D product authenticity antecedents (i.e., control and animated colours) on the creation of a 3D product authenticity construct, which in turn impacts consumers' experiential and instrumental values. To identify how using a 3D product visualisation influences the consumers' VE, we add to the marketing literature the notion of 3D product authenticity and present a valid scale to measure it. As such, it is the first study to empirically explore the antecedents of 3D product authenticity (control and animated colours) and connect them to the 3D product authenticity construct. The emergence of the notion of 3D product authenticity makes it easier for marketers and practitioners who are interested in using 3D to simulate real products in the non-store retailing environment to use and apply this notion to measure consumers' VE. Previous scholarly literature (e.g., Coyle and Thorson 2001; Klein 2003; Li et al 2002, 2003) has defined and operationalised VE based on the notion of telepresence. The original telepresence theory has evolved and been established in the IVR environment, and marketing scholars have adopted this theory and used the same measurement scale that scholars from the IVR field have used to measure consumers' VE. However, having such a scale within the non-store retailing environment may confuse marketers and users because what measures TV telepresence, for example, might not be applicable for the 3D computer. Furthermore, the 3D telepresence scale is centred on products that do not usually exist (Lombard and Ditton 1997). Instead, our 3D product authenticity construct refers to the ability to imagine a virtual object as real. Our results support the previous theoretical work of Lee (2004), which revised previous definitions of telepresence and presence and argued that none of the previous definitions could be used to illustrate the concept of using virtual environments to reflect the consumer VE. Lee proposed using "para-authentic objects" to simulate virtual versions of real life objects. Our results provide empirical support for that proposition. Furthermore, our 3D product authenticity construct reflects Klein's (2003) notion of realism in the field of VE, which Klein advised marketers to apply in order to positively influence product beliefs.

The conceptual framework results reveal the usefulness of our framework in interpreting and understanding the relationships among the control, animated colours, 3D product authenticity, experiential and instrumental values. Our results provide strong evidence of the influence of control and animated colours on 3D product authenticity (which enables consumers to see the 3D virtual model of a product as authentically real) and the impact of 3D product authenticity on experiential and instrumental values. In support of other research (e.g., Coyle and Thorson 2001; Klein 2003), we find that control and animated colours are the main tools that enhance consumers' VE. Furthermore, we find that control and animated colours are the main antecedents of the 3D product authenticity construct. In support of the previous findings of Hopkins et al. (2004) and Coyle and Thorson (2001), which found that media richness has a stronger impact on perceived 3D (in comparison to user control), we find that the animated colour construct is a stronger determinant of 3D product authenticity than the control construct.

Results of this research (3D product authenticity consequences) support previous research that reports the ability of 3D to provide customers with more information and fun (e.g., Kim and Forsythe 2008; Fiore et al. 2005a; Yang and Wu 2009). We find that 3D product authenticity produces more experiential values than instrumental values. Furthermore, we find that experiential and instrumental values are the main consequences for a consumer interacting with an authentic 3D virtual model. An authentic 3D product visualisation enables consumers to experience online products without directly inspecting them; it makes non-store retailers the best place to examine a product virtually; and it provides consumers with a sense of having a direct experience with the product (Coyle and Thorson 2001).

Theoretical Implication

Previous research on VE has focused on three elements to surpass the offline (direct) experience: interactivity, vividness and 3D telepresence. However, we claimed that the notion of 3D telepresence has negative connotations. Instead, we propose the notion of 3D product authenticity to reflect the real VE. Moreover, we narrowed the operationalisations of 3D product authenticity antecedents to control and animated colours in order to reflect a real authentic VE.

In line with other online retail researchers who have investigated the influence of using 3D product visualisation on VE (Li et al. 2001, 2002, 2003), we find that marketers should focus on specific aspects of interactivity and vividness (rather than on the abstract constructs) when defining the 3D VE. For example, the empirical support for control as a representation of interactivity resolved a long debate among previous researchers. When it comes to 3D virtual models, we prefer focusing on the narrowest, most relevant aspects of interactivity (i.e., control). Whereas Heeter (2000, p. 75) describes interactivity as "*an overused and under defined concept*", we posit that control represents a useful construct for 3D models in the online retail context, in support of previous research (Ariely 2000; Coyle and Thorson 2001). We narrow our conceptualisation of control to consumers' ability to control the content and form of the 3D flashes. In other words, users' ability to zoom in or out, rotate and get more information about the product enhances their perceptions of the authenticity of the 3D products. Furthermore, whereas prior research defines vividness according to sensory breadth and depth, we argue that research might benefit from a tighter focus on specific aspects of vividness through illustration, as we have in this research. This result is in accordance with the study of Pimentel and Teixeira's (1994, p. 146) that asserts that visual stimuli are the main sensory cues in producing virtual experiences.

Managerial Implications

In a highly competitive environment, non-store retailers need to find ways of attracting and retaining customers (Khakimdjanova and Park 2005; Mummalaneni 2005). A website with an authentic 3D product visualisation is an important stimulus that usually helps non-store retailers to be successful, and it often helps them enhance the e-shopping environment (Khakimdjanova and Park 2005; Park, Stoel and Lennon 2008). Non-store retailers should pay more attention to 3D product authenticity antecedents, i.e., control and animated colours, when designing their 3D virtual models. Including real colours and flashes that consumers can easily control will lead to a more authentic VE. Website developers should improve user perceptions of the authenticity of the 3D. To achieve this, website developers should consider the importance of the control and animated colours factors. The empirical results of this research reflect the importance of the participants' ability to easily zoom in or out on a laptop, and rotate it (control construct). Moreover, the participants' ability to change the laptop colours (animated colours) is considered another important aspect for enhancement of user perceptions of 3D product authenticity. Moreover, retail website designers can contribute to enhancing consumers' VE by focusing more on the experiential and instrumental values. Any 3D flash should include the essential information that consumers are seeking, rather than just a pretty picture. For example, consumers should be able to click on any part of the 3D flash to get instant information about the laptop. Previous researchers have focused on the ability of 3D effects to reflect general information (perceived sensation knowledge) to the audience, such as the overall appearance of the products (e.g., Fiore et al. 2005a). Therefore, we encourage managers and website designers to work together to ensure that the 3D product visualisation provides customers with the complete and accurate information they need. In addition, marketers should decide what information to focus on before developing any 3D flash. Marketers and managers should focus on the experiential experience: adding an innovative 3D flash with more experiential value often enhances the consumer's search, which may result in the consumer making a purchase from the online retailer (Kim and Forsythe 2007, 2008).

The significant effect of 3D product authenticity on experiential and instrumental values suggests that a highly-designed 3D flash not only helps participants to easily consume relevant information, but also allows them to have more fun, through navigation of the 3D flashes. A 3D product visualisation enriches the consumer's sensations and perceptions of the online retailer, and is a very important tool for attracting consumer attention (*Childers et al.* 2001; Eroglu, Machleit and Davis 2003; Fiore 2008). Website developers should take advantage of technological advancements and keep developing and updating the online retailers' 3D flashes. Otherwise, if all of the industry competitors use the same 3D flashes, then the animation will not attract the consumer attention (Fasolo et al. 2006).

It should be accepted that developing 3D flashes is not a low-budget issue. Nevertheless, Nantel (2004) asserts that consumers shopping online for clothing are 26 per cent more likely to purchase from the sites that have 3D virtual models than from sites that do not. Moreover, Fiore (2008) posits that media richness is an important way to differentiate non-store retailers. Wagner (2000) asserts that online retailers with 3D product visualisations may reap benefits that extend beyond sales. For example, 3D effects increase site stickiness: users will spend more time on the online retailer, which leads to more opportunities to learn more about the products, interact with them, build trust and confidence. Finally, according to a Social Issues Research Centre (SIRC, as cited in Herrod 2007) study, it is expected that "by 2020 virtual commerce (v-commerce) will replace e-commerce" and the development of 3D virtual models (such as 3D virtual shopping malls) will be leading the whole industry by 2020.

LIMITATIONS AND FURTHER STUDIES

Although the generalisability of the results is limited by the student sample and cannot be generalised to all online consumer groups, we argue that students represent the shoppers of tomorrow, are computer-literate, have few problems using new technology, and are likely consumers of electronic goods (Balabanis and Reynolds 2001). Thus this research has prescient value. Secondly, since this study has focused only on laptops, which we considered to be products that are associated with more search or experience, it is unclear to what extent the results can be generalised and applied to other online products.

Even though we have not investigated the impacts of experiential and instrumental values on consumer behaviour, the relationships appear to be well founded in the non-store retailing context (Fiore et al. 2005a, 2005b; Kim and Forsythe 2007; Lee et al. 2006; Yang and Wu 2009). For example, Fiore et al. (2005a) asserts that significant relationships exist between experiential and instrumental values (extracted from 3D virtual models) and a willingness to purchase from an online retailer. Yang and Wu (2009) posit that experiential and instrumental values have strong impacts on e-shopping satisfaction. Thus, developing and designing 3D product visualisation, within the non-store retailing industry, to reflect the authenticity of the 3D product, not only enhances the emotional and cognitive aspects of the product, but also often boosts consumer purchasing in the non-store retailing environment. We recommend research efforts to consider (i) whether 3D product authenticity and experiential and instrumental variables have direct or indirect effects on behavioural intentions, (ii) whether adding auditory cues to the 3D flashes influence behavioural intentions, and (iii) extending the generalisability of our findings to other contexts and samples, since we designed and collected the data using a mock-up retail website.

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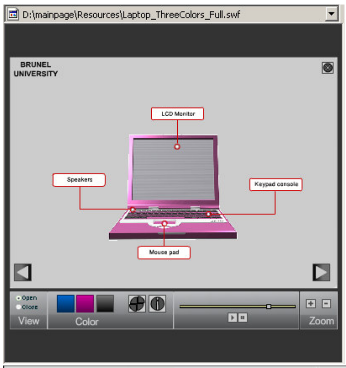
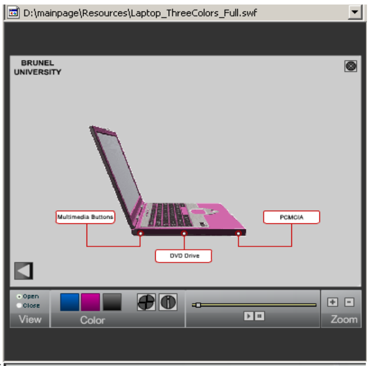
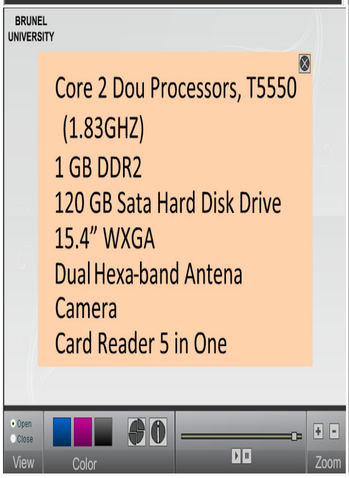
Appendix A:


D:\mainpage\Resources\Laptop_ThreeColors_Full.swf
BRUNEL UNIVERSITY
LCD Monitor
Speakers
Keypad console
Mouse pad
Open
Close
View
Color
Zoom


D:\mainpage\Resources\Laptop_ThreeColors_Full.swf
BRUNEL UNIVERSITY
Multimedia Buttons
PCMCIA
DVD Drive
Open
Close
View
Color
Zoom


BRUNEL UNIVERSITY
Core 2 Dou Processors, T5550
(1.83GHZ)
1 GB DDR2
120 GB Sata Hard Disk Drive
15.4" WXGA
Dual Hexa-band Antena
Camera
Card Reader 5 in One
Open
Close
View
Color
Zoom


BRUNEL UNIVERSITY
Open
Close
View
Color
Zoom


Open
Close
View
Color
Zoom


BRUNEL UNIVERSITY
Open
Close
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Color
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