

## The Effect of 3 Dimensional Virtual Reality Retail (VRR) Store Ambiance on Avatar's Emotions and Behaviour: A Mediation Analysis

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### Abstract

This study carefully employs a One-Group Pre and Post Test approach of Quasi experimental research design to investigate the effect of ambiance (specifically *colours*) on avatars' emotions and behaviours in 3 dimensional (3D) Virtual Reality Retail (VRR) stores. In order to conduct an analysis of the data collected from Second Life (SL), a highly advanced 3D Virtual World, this study employed the PROCESS tool. The research provides empirical evidence supporting the significance of *colours* as a prominent environmental cue in three-dimensional virtual reality retail stores. This study examines the influence of colours on the emotional states and behaviours of avatars. It specifically focuses on the significant impact of colours on approach/avoidance behavioural intentions, which is mediated by arousal and pleasure. It provides a significant contribution to the current body of literature on retail atmospherics by enhancing comprehension of 3D virtual reality retail environments and the significance of colour schemes. It is important to mention that the impact of arousal in isolation was determined to be statistically not significant. The present study offers interesting insights; however, it is important to acknowledge certain limitations. These limitations include the narrow focus on a certain type of specialised 3D VRR store, and the constraints imposed by a very small sample size. Future research within this subject should aim to address these limitations.

**Keywords:** *Ambience, Retail Atmospherics, Colours, 3D Servicescape Model, S-O-R Model, Shoppers' Emotions, Shoppers' Buying Behaviour, 3D Virtual Reality Retailing, Virtual Worlds*

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### 1 INTRODUCTION

The advancement of technology has facilitated the ability for individuals to engage in online shopping, enabling them to conveniently make purchases from the confines of their own residences, hence eliminating the need of physically visiting traditional physical retail stores. The terms "web retail shops," "online retail stores," and "web 2.0 retail stores" are used interchangeably to refer to stores that cater to shoppers via online platforms. Plethora of scholarly research has been conducted to study the effect of both physical (brick & mortar) stores and online stores on shoppers' emotions and behaviour. The first investigation in this particular field was conducted by Eroglu, Machleit, and Davis (2001) during the year 1999, with the subsequent publication of their findings occurring in 2001. Extensive research has been conducted within the realm of online shopping and its impact on various shoppers' behaviours throughout the last two

decades, despite its relatively recent emergence as a subject of scholarly inquiry. The process of purchasing items using online platforms differs significantly from the traditional practice of physically visiting a brick-and-mortar retail store. Shoppers who engage in shopping activities at brick-and-mortar retail stores are frequently exposed to many environmental stimuli, including the spatial arrangement (aisle layouts) of the store, ambient temperature, and olfactory cues. When shoppers engage in online shopping, they are evidently deprived of these sensory inputs as many brick and mortar environmental cues are not present in online retail stores. Conversely, the domain of e-commerce offers opportunities for engagement with different cues that are not available in traditional brick-and-mortar stores, such as the arrangement of items and the various navigation methods used (Manganari et al., 2011). Numerous environmental cues have been examined within the realm of online buying, and these include the correlation between music and colour as explored by Price-Rankin (2004), the examination of website layout and design by Vrechopoulos et al. (2004) and Manganari et al. (2011), the evaluation of online shop quality and branding by Chang (2008), and the analysis of visual components, colours, and linkages on websites by Koo and Ju (2010).

However, in the present day, shoppers have the opportunity to use further advanced online buying platforms such as 3D virtual reality retail stores also known as 3D VRR. A number of retail scholars have extensively investigated the cognitive processes and behavioural patterns shown by shoppers in both brick-and-mortar and web stores (Massara, 2003; Vrechopoulos et al., 2004; Chang et al., 2008; Dijkstra, 2008; Iyiola, 2011; Manganari et al., 2011). However, there is only a limited research available within the realm of 3D virtual reality retail atmospherics. The veracity of this claim has been supported by many retail studies conducted by Vrechopoulos et al. (2009), Krasonikolakis et al. (2011), Hassouneh et al. (2015), Dad et al. (2016), and Dad et al. (2018). A significant difference may be observed between the ambience of an e-commerce platform and a brick-and-mortar retail store. When engaging in online shopping, shoppers have the opportunity to avoid intermediaries i.e. any complications arising from adverse weather conditions or traffic jam while their way to shopping malls. Based on the research conducted by Aldiri et al. (2010), it is obvious that both shoppers and online retailers may experience a decline in their trust in the brand. In the context of 3D virtual reality retail (VRR) environments, the presence of virtual characters (avatars), such as other customers or staff members, has the potential to moderate existing disparities of Web 2.0 retail stores. In addition to the convenience of web shopping, 3D VRR stores provide distinctive and captivating experiences, such as immersing oneself in a bustling marketplace or entirely supporting the pleasure of virtual flight (Wang, 2003; Dad et al., 2016; and Dad et al., 2018). Several studies have shown an increase in the number of shoppers and financial transactions occurring inside 3D VRR shops. The aforementioned studies include the scholarly work of Vrechopoulos et al. (2009), Haenlein et al. (2009), Krasonikolakis et al. (2011), Hassouneh et al. (2015), Dad et al. (2016), and Brookes et al. (2019).

Nevertheless, the existing literature has not thoroughly investigated the effect of 3D virtual reality retail atmospherics. This study aims to extend existing research conducted on web-based and conventional retails by investigating the potential implications of these concepts in 3D VRR atmospherics. The objective of this research is to examine the effect of environmental cues, particularly colours, inside 3D virtual reality retail (VRR) settings on the emotions (namely pleasure & arousal) and behavioural responses (approach/ avoidance) of avatars.

## 2. LITERATURE REVIEW

The merging of virtual reality (VR) with the gaming world has led to the development of modern virtual worlds (VWs) (Sivan, 2008; Ball, 2022). Furthermore, it has been suggested that virtual reality (VR) may be considered its father, while gaming may be called its mother. These VWs, according to Girvan (2018), are founded on fundamental concepts of economics, social science, commercial activities, law, natural science, applied science and computer science. A computer-generated environment that provides a high level of immersion, interactivity, and creative potential is referred to as virtual reality (VR). Virtual worlds (VWs), according to Battal and Tasdelen (2023), arose following the emergence of game worlds. Virtual Worlds have been offered on a worldwide scale since 1978. The first version of Multi User Dimension (MUD), commonly known as the first multiplayer game, was largely text-based and lacked visual graphics. Second Life (SL), There.com and Ultima Online are some of the most well-known advanced level virtual worlds. VWs were first uncommon, however, the spread of technology, as well as the growing availability of high-speed, low-cost broadband, has contributed to a substantial increase in the user base of Virtual Worlds (VW) (Battal & Tasdelen, 2023). VWs have gone through a maturity phase and are now distinguished by their widespread proliferation. Parker et al. (2023) discovered that real-world businesses are also considering virtual worlds as another platform to perform their commercial activities.

The metaverse market is presently valued at more than \$74.4 billion, demonstrating that it is rapidly expanding. Significantly, investors have committed over \$500 million to metaverse real estate, reflecting their steadfast belief in its development potential. Furthermore, it is worth noting that bitcoin assets are held by a sizable 53% of firms involved in metaverse investing. Approximately 400 million monthly active users contribute significantly to the metaverse's life. Roblox, the most populated virtual environment in the metaverse, attracts a notably young population, with 51% of its users under the age of 13.<sup>1</sup> Furthermore, metaverse market is expected to grow at an annual rate of 37.73% and hence it is forecasted the overall market value will increase up to \$507 billion by 2030. Though, metaverse market is growing worldwide and businesses are considering these platforms for commercial activities however, under developing countries are still lacking in their technological infrastructure and it may be argued that it might take few more years for under developing economies to have metaverse commonly used for any kind of commercial activities.

The pull of the metaverse is obvious among a diverse American population, with 74% considering or currently participating in activities inside this digital domain. According to predictions, 25% of Americans will dedicate at least an hour per day to metaverse-related activities by 2026, indicating that the metaverse's importance will continue to grow.

Occurrences inside the metaverse, such as Marshmello's Fortnite concert, when he performed live in front of 10.7 million people, highlight the metaverse's ability to host massive virtual experiences.<sup>1</sup>

### 2.1 3 Dimensional Virtual Reality Retail (3D VRR) Stores

3 Dimensional Virtual Reality Retail stores provide an immersive shopping experience to shoppers where shoppers can buy any digital product by using their virtual currency i.e. in case of Second Life virtual currency which is acceptable over there is called Linden Dollars (Vrechopoulos et al., 2009; Dad et al., 2016 & 2018; Kang, 2020; and Billewar et al., 2022). Within the virtual world of Second Life, users, represented by avatars, engage in economic activities by utilising a digital

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<sup>1</sup> Metaverse Market - Statistics For 2023-2024

currency known as Linden Dollars (L\$). These transactions mostly occur within 3D VRRs that exist within the VR environment of Second Life (SL). The current state of 3D VRR stores is primarily in the developing stage, yet they effectively replicate the experience of classical brick & mortar stores (Lau et al., 2013; Kang et al., 2020; and Billewar et al., 2022). 3D virtual reality retail (VRR) stores engage computer graphics to present a visual representation simulating physical brick-and-mortar stores. These simulations encompass number of atmospherics i.e., ceilings, wall, aisles, colours, lights, design and etc. Nevertheless, online retail stores cannot be considered a direct substitute for classical brick & mortar retail stores as web-based online retail stores have been found to demonstrate some issues (Haenlein & Kaplan, 2009). Many studies (Wang et al., 2007; Vrechopoulos et al., 2009; and Dad et al., 2016; Roggeveen et al., 2020; and Giao et al., 2020) highlighted the limitations of product images in Web-based online stores such as the absence of 3D representation, the lack of social cues, and the resulting dissatisfaction by shoppers with their shopping experience. 3D VRR stores provide shoppers the opportunity to develop their digital personalities through avatars in that may closely resembles and replicates the sensory exposure of a tangible real-world identity. The design and resemblance of avatars to match the user's real world height, body composition, and facial shape might vary depending on the user's level of expertise. In order to enable shoppers' decision-making, it has been suggested by various researchers (Donovan & Rossiter, 1982; Areni & Kim, 1993; Yalch & Spangenberg, 1993; Chebat et al., 1993; Machleit et al., 1994; Wakefield & Baker, 1998; Spangenberg et al., 2006; Eroglu et al., 2001 & 2003; Wang, 2003; Vrechopoulos et al., 2004; Price-Rankin, 2004; Ward et al., 2007; Quartier, 2009; Koo & Ju, 2010; and Hussain & Ali, 2015) that consumers should have the ability to virtually try on different types of clothing using their avatars prior to making a real purchase in such 3D VWs.

Since the year 2003, virtual worlds and 3D VRR stores exist; however, research on these retail atmospherics is still limited, as indicated by studies conducted by Krasonikolakis et al. (2011), Hassouneh and Brengman (2015), Dad et al. (2016), Roggeveen et al. (2020) and Giao et al. (2020). Past studies have focused on exploring many aspects of virtual worlds, however, there is a significant dearth of investigation into the impact of 3D VRR atmospherics on avatars' emotions and behaviour. A limited number of scholarly investigations (Vrechopoulos et al., 2009; Krasonikolakis et al., 2011; Hassouneh & Brengman, 2015; Dad et al., 2016 & 2018; Krasonikolakis et al., 2018; Roggeveen et al., 2020; and Giao et al., 2020) have examined the atmospherics within 3D VRR stores. Dad et al. (2016) introduced the concept of '3D Servicescape', which incorporates the comprehensive 3D VRR atmospherics. The 3D Servicescape model incorporates a total of 21 atmospheric cues, ranging from virtual air to avatar's compatibility. However, further investigation has been advocated to find out the validated and reliable results in this particular domain. Hence, the objective of this study is to investigate the effect of the 3 dimensional retail atmospherics, explicitly focusing on the "Colours," on the emotional and behavioural responses of avatars. The investigation of colours has been conducted in research pertaining to physical and web-based retail atmospherics (Berman & Evan, 1995; Turley & Milliman, 2000; Rosenbaum and Massiah, 2011; Areni & Kim, 1993; Baker et al., 1994; Reddy et al., 2011; Baker et al., 1994; Countryman & Jang, 2006). However, the significance of colour as a crucial element of the retail atmospherics has yet to be explored in the context of three-dimensional virtual reality retail establishments. In this study, 3D Servicescape model, proposed by Dad et al. (2016), has been adapted to explore the effect of colours in 3 dimensional retail shops on the emotional and behavioural responses of avatars. This study specifically investigates how pleasure and arousal mediate this relationship, as seen in Figure 1.

The 3D Servicescape model has been developed upon the affect model of Mehrabian and Russell (1974) which serves as one of the most comprehensive theoretical framework for examining the effect of built environments on emotions and behaviours. This model specifically focuses on the role of emotions as mediating variables (Mehrabian & Russell, 1974 & 1976; Russell & Pratt, 1980; Prince-Rankin, 2004; Graa & Dani-elKebir, 2011; Dad et al., 2016 & 2018).

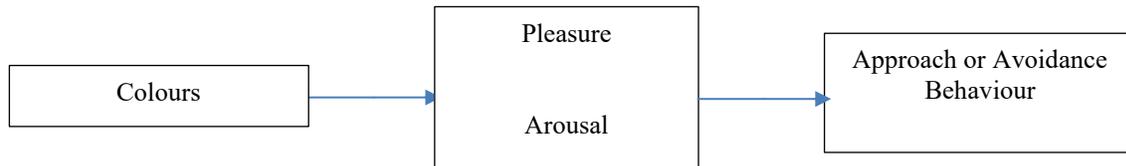


Fig. 1. Conceptual Framework of this Study to Examine the Effect of Colours as one of the important cue of ambiance on Avatars' Emotions and Behaviour

The present study focusing on the response of avatars towards distinct colours within the context of 3D VRR stores. The adaptation of colours is a dominant aspect within retail atmospherics (Berman & Evans, 1995; Turley & Milliman, 2000). According to Rosenbaum and Massiah (2011), colours are considered as a significant atmospheric of physical retail atmospherics. Wide range of studies have been conducted to investigate how *colours* affect shoppers in brick-and-mortar retail stores (Bellizzi & Hitte, 1992; Spies et al., 1997). Past studies have examined the effect of colours on different variables of shoppers' behaviour such as shoppers' pleasure levels was investigated by Reddy et al. (2011), service and product quality were explored by Baker et al. (1994), and the overall retail ambience were explored by Baker et al. (1994) and Countryman and Jang (2006). However, inadequate studies are available which explore the effect of *colours* in online retail settings (i.e., Eroglu et al., 2001 & 2003; Price-Rankin, 2004; Koo & Ju, 2010; Kim & Lennon, 2010). These mentioned studies have proven that the utilisation of colours within online retail atmospherics have a noteworthy effect on shoppers' pleasure, arousal, shopping intentions, as well as their trends towards approach or avoidance behaviours.

### 3. RESEARCH METHODOLOGY

The adaptation of experimental research design is believed to be essential to achieve this study's objectives and effectively eliminate the effect of extraneous variables, as experiments are considered most appropriate for investigating the correlations between variables especially when objective is to achieve accuracy (Wang, 2003). However, theoretical part must give priority to internal validity, as emphasised by Cook (1976). Additionally, this research adapts the 3D Servicescape model, developed by adapting the S-O-R Mehrabian and Russell's model (Figure 1), and examines the relationship among demonstrated variables. This study opted for the application of a "natural field experiment", as discussed by Harrison and List (2004) and investigates participants within 3D VRR stores in Second Life, which were considered as a "natural setting" environment within computer labs. Further, the research design adapted in this study is a one-group pre-test-post-test design. The performance quality of Second Life, i.e. responsiveness and robustness, are

subject to several factors, including the quality of the Internet connection, the competence of the graphic card, and the processor. The experiment necessitated controlled environmental settings.

While the surroundings of the 3D VRR shops were not manipulated, the study participants were carefully manipulated and instructed. Over a period of 12 weeks, the participants methodically visited 3D VRR stores in a prearranged schedule. The survey questionnaire was employed to investigate arousal, pleasure, 3D VRR background colours, and approach/avoidance behaviour. All items and scales of the adapted questionnaire were adopted based on experts' opinion and after conducting a pilot study.

The initial section of the questionnaire provides detail describing the goal of the research, and instructions on how to complete the questionnaire. The next 12 items investigate emotional responses, focusing on pleasure and arousal. Participants were asked to rate their emotional state on a 6 point Likert scale against all 12 x items indicating emotional states, as adapted from Mehrabian and Russell (1974), Donovan and Rossiter (1982), Newman (1997), and Dad et al. (2016). The third part of the questionnaire was the repetition reexamine the aforementioned emotional responses in order to reassess and compare the levels of pleasure and arousal experienced by participants pre and post-test. The fourth part of the questionnaire investigated the presence of colours within 3D VRR stores. In the fifth part, an investigation was conducted with the help of 4 items that examine participants' approach/avoidance response within the context. Fourth & fifth parts of the questionnaire employed a six-point symmetric scale, ranging from 1 to 6, where 1 represents "strongly disagree" and 6 represents "strongly agree". The sixth part of the survey included questions related to demographic information such as age group, sex, profession and etc. This study investigates the phenomenon of "freebie" 3D VRR stores within the Second Life.

### **3.1 Industry Selection**

Experiments were conducted in the VW of Second Life. The age range of most participants was observed between 23 and 50 years. Only Fashion and Style apparel stores were shortlisted for the experiments and rationale was based on their higher likelihood of attracting foot fall, as opposed to VRR stores falling under the institution and lawns or property and realtors categories. In an earlier study the effect of music was investigated in same regions but different shops Dad et al. (2019).

### **3.2 Data Collection**

In summer 2022, researchers initiated approaching with avatars visiting in the vicinity of above-mentioned locations and sending an invitation for their participation in the study. The objective for the designated timeframe was to maximise participant recruitment for the research undertaking. Prior to starting the actual research phase of the One-Group Pre & Post-test quasi-experimental design, participants were had the opportunity to familiarise themselves with the surroundings by engaging in a guided tour of the selected 3D VRR stores. The initial scheduled tours were executed in July 2022. Researchers, for this research, used i9 7th generation PCs and a 100 mpbs Internet connection, facilitating the uninterrupted visits of Second Life. The avatars were requested to engage in the study on a voluntary basis. The study involved the participation of 140 Avatars who completed surveys using the Second Life Chat Box. A thorough review was conducted to confirm that all forms have been filled without any instances of incomplete or missing values.

## 4 RESULTS AND ANALYSIS

### 4.1 Paired Sample T-Test

The effect of the colours was decided to be assessed by examining the emotional responses of avatars before and after exposure to different backdrop colours in a 3D VRR setting. As there was a possibility that the colours utilised in the VRR stores did not demonstrate a significant effect on the avatars' emotional states, whether positive or negative. Therefore, the t-test was conducted for the purpose of comparing two means (Field, 2013). There exist two types of t-tests, namely *paired sample t tests* and *independent sample t tests* however, the paired-sample t-test is recommended in two experimental scenarios involving the same group of individuals (Field, 2013).

This study observed a significant effect of colours present in 3D VRR stores on avatars' emotional and behavioural response sets as demonstrated in Table 1.

**Table 1: Paired Sample t-Test**

		Mean	N	Std. Deviation	Std. Error Mean
<b>Pair 1</b>	<b>Post Pleasure</b>	5.3244	140	0.78340	0.06621
	<b>Pre Pleasure</b>	4.8343	140	0.75694	0.06397
<b>Pair 2</b>	<b>Post Arousal</b>	5.0112	140	0.80786	0.06828
	<b>Pre Arousal</b>	4.5412	140	0.82539	0.06976

Table 1 shows the average value of the avatars' pre-exposure pleasure, denoted as "Pre-Pleasure," which determines to be 4.8343. The mean pleasure value of the 140 subjects, referred to as "Post Pleasure," following their exposure to the 3D VRR retail colours, were found to be 5.3244. In a similar vein, the average pre-arousal level was recorded as 4.5412, whereas the average post-arousal level was measured at 5.0112.

**Table 2: Paired Samples Correlations**

		N	Correlation	Sig.
<b>Pair 1</b>	<b>Post Pleasure and Pre Pleasure</b>	140	0.628	0.000
<b>Pair 2</b>	<b>Post Arousal and Pre Arousal</b>	140	0.404	0.000

Table 2 and 3 indicates the paired sample correlation and t-test results. Pair 1, consisting of pre- and post-pleasure measurements, exhibits a correlation coefficient of 0.628, indicating a statistically significant relationship at a p-value of 0.000. Pair 2 is representing arousal and has a paired sample correlation coefficient of 0.404, indicating a statistically significant relationship at a p-value of 0.000. In SPSS, the default confidence interval has been set at 95%. Consequently, the determined 95% confidence interval for the variance in pre & post pleasure effect is found between 0.33017 to 0.44146. The confidence range for pre & post arousal is estimated to be between 0.2554 to 0.62450. Further the *t values* for pleasure and arousal were found to be 5.143 and 4.621 respectively, with a total of 139 degrees of freedom. The two-tailed p-value for the paired t-tests conducted on Pair 1 and Pair 2 is 0.000. This p-value represents the probability of observing a test statistic as extreme as the observed result, given the alternative hypothesis that the mean difference is not equal to zero. Moreover, the findings indicate that the p-value for pleasure and arousal is 0.000, which is equivalent

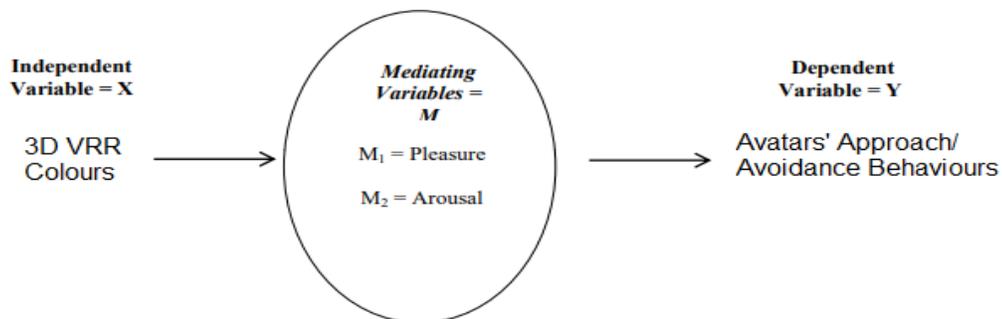
to 0.05 (Pair 1 and Pair 2). According to Field (2013), the  $p$ -value  $< 0.05$  shows a statistically significant difference between the scores of two variables.

**TABLE 3: PAIRED SAMPLES TEST**

		Paired Differences					T	df	Sig. (2-tailed p-value)
		Mean	Std. deviation	Std. error mean	95% Confidence interval of the Difference				
					Lower	Upper			
<b>Pair 1</b>	<b>Post Pleasure / Pre Pleasure</b>	0.49659	0.79796	0.06744	0.33017	0.44146	5.143	139	0.000
<b>Pair 2</b>	<b>Post Arousal/ Pre Arousal</b>	0.45638	0.92953	0.07856	0.2554	0.62450	4.621	139	0.000

#### 4.2 Mediation Analysis

Mediation analyses is highly recommended for investigating the effect of independent variable(s) on dependent variable(s) while mediating variable(s) is present (Hayes, 2014). This research focuses on the effect of Colours as an Independent Variable 'X' on Approach/ Avoidance Behaviour which act as a Dependent Variable 'Y', while having two mediating variables between them (See Figure 2)



**Fig 2. Conceptual 3D VRR Store Environment Affecting Avatars' Behaviour Through Mediating Variables of Pleasure (M1) and Arousal (M2)**

Mediation analyses is highly recommended in such case, as demonstrated in Figure 2 above, as compared to Structural Equation Modelling (SEM) as SEM does not analyse the effect in singular path. In order to enhance accuracy, Hayes (2013) recommends the adoption of the PROCESS approach as an alternative of SEM. And hence in this research, the PROCESS approach is preferred over Structural Equation Modelling (SEM) to examine the relationships independent, mediating, and dependent variables due to its competitive features in the present circumstances. Additionally, the use of PROCESS is also highly recommended by Field (2013) as a suitable approach for doing multiple regression analysis including mediating factors.

In the context of serial multiple mediation, Hayes' Model 6 is adopted rather than Model 4. The sequential arrangement of the mediating variables has significance in Hayes' Model 6 of the PROCESS command but not in Model 4. In this model, arousal and pleasure levels are mediated sequentially by Model 6. And it has been observed that colours in 3D VRR stores are not having any effect on behaviours through the mediating variable of Arousal in isolation which rejects the initial propositions of the Mehrabian and Russell's (1974) S-O-R model.

### 4.3 Results of Mediation Analysis

The relationship between pleasure (M1) and colour is indicated by the regression coefficient ( $b = 0.3244$ ,  $p = 0.0001$ ,  $t = 4.2001$ ). The results indicate that colours had a significant influence on M2 Arousal ( $b = 0.1709$ ,  $p = 0.0027$ ,  $t = 3.0800$ ). The level of arousal has a significant impact on the experience of pleasure in the Outcome, as indicated by the regression coefficient ( $b = 0.6042$ ,  $p = .0000$ ,  $t = 9.2405$ ), which is statistically significant at the alpha level of .05. The influence of arousal on avatars' behaviour in Outcome is found to be insignificant, as indicated by the statistical results:  $b = 0.0739$ ,  $p = 0.5930$ , and  $t = 0.5362$ . The results of the PROCESS Outcome analysis indicate that pleasure had a significant influence on avatars' behaviour ( $b = 0.4368$ ,  $p = 0.0055$ ,  $t = 2.8370$ ). The diagram known as "Indirect Impact Path 1" depicts the manner in which colours have an indirect influence on both arousal levels and the approach/avoidance behaviour. The initial indirect impact is calculated to be 0.0240. The bootstrap confidence interval encompasses zero, indicating that the observed effect size is not statistically significant (-0.0418 to 0.1327). The second indirect effect, known as "Indirect impact path 2," elucidates the sequential influence of colours on avatars' behaviour, namely the pathway from colours to arousal and then to pleasure. The estimated second indirect impact is 0.0856. The bootstrap confidence interval demonstrates a statistically significant positive path of impact, ranging from 0.0325 to 0.1717. The third indirect effect path examines the relationship between colours and their influence on individuals' happiness and conduct. The correlation coefficient between colours, pleasure, and avatars' approach/avoidance behaviours is 0.0746. The bootstrap confidence interval, which ranges from 0.0162 to 0.1793, indicates that the observed link path is statistically significant as it does not include zero in it. Further, the model which measures the collective indirect effect by summing all individual indirect effects is known as the serial multiple mediator model. The bootstrap confidence interval indicates that the indirect impact is positive, with a value of 0.3664 (95% CI: 0.1957 to 0.5371). The statistical analysis reveals that the indirect impacts of the colours offered by the 3D VRR stores, specifically the second, third, and overall effects, demonstrate a significant effect. The path of the total indirect effect is highly significant due to the significance of the total indirect value. Figure 3 illustrates the substantial impact of colours on the conduct of avatars, mediated through the variables of arousal and pleasure.

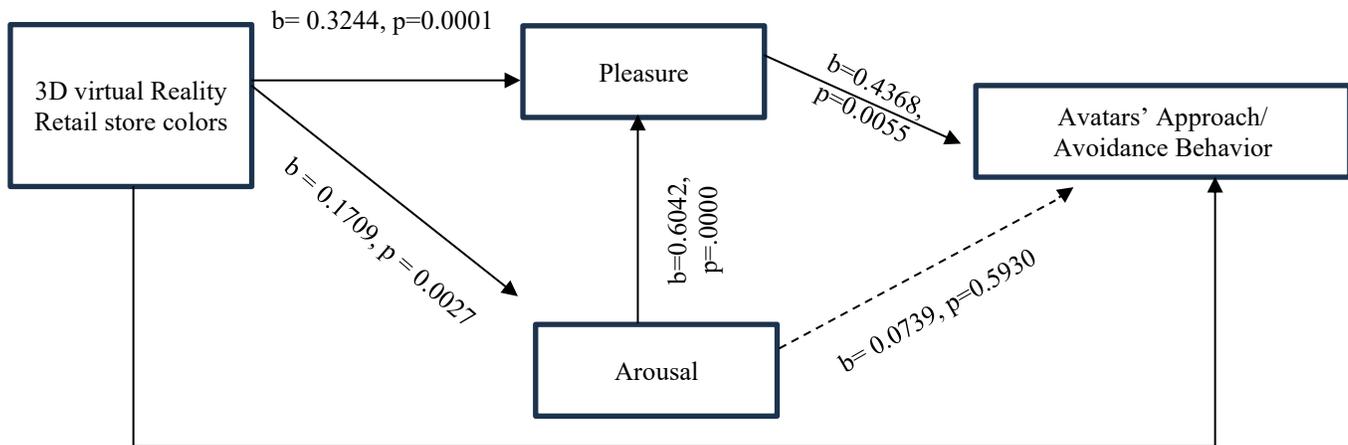


Fig 3. Depicting Direct/Indirect Significant/Insignificant Relations Between X and Y Through M1 and M2

## 5 DISCUSSION

Previous research studies (Bellizzi & Hite, 1992; Yalch & Spangenberg, 2000; Price-Rankin, 2004; Countryman & Jang, 2006; Kim & Lenon, 2010; and Roggeveen et al., 2020) have supported that colours do have significant effect on shoppers' emotions as well as behaviour in retail stores. Similarly, it has been observed that colours also play a significant role in 3D virtual reality retail (VRR) stores. This study investigated the effect of colours on the emotions and behaviour of Avatars, highlighting both direct and indirect effects by adapting mediating analyses of Hayes. The influence of colours on the approach and avoidance behaviours of avatars is observed to be significantly mediated by arousal and pleasure. Nevertheless, this research rejects the initial proposition of M-R model (1974) and supports Dad et al. (2018) study of music in 3D VRR stores and concludes that the effect of colours on avatars' behaviour is not primarily driven by arousal solely. Figure 3 illustrates the effect of colours on the emotional and behavioural responses of avatars engaged in shopping activities within 3D VRR stores. Additionally, it shows the significant indirect path by which colours affect approach or avoidance behaviours through the mediating variables of pleasure and arousal.

## 6 Conclusion

This study determines that the background colours, as one of the important environmental cue and component of ambiance, in 3 dimensional Virtual Reality Retail stores have a significant effect on the emotional state (pleasure and arousal) of avatars, as well as their consequent approach/ avoidance behavioural responses. The effect of colours on shoppers in a retail setting has been confirmed by plethora of previous studies. However, this study provides more evidence that aligns with the findings of Rosenbaum and Massiah's (2011) study, which determined background colours as a significant atmospheric cue. This study examines the use of colours as a mean of determining the degrees of pleasure and arousal in 3D VRR stores, therefore supporting the findings of Reddy et al. (2011). Further, this study also revealed that the effect of colours on arousal, as well as enhanced degrees of arousal, had a favourable correlation with pleasure and approach/ avoidance behaviour. Moreover, the results of this study imply that the second and third indirect effect paths are significant, confirming that colours significantly affect arousal, leading to increased levels of pleasure and approach behaviour in avatars. Significantly, the present study has determined that the adaptation of the M-R (1974)

within the 3D VRR stores reveals that the mediating variable of "arousal" does not have a significant direct effect on the approach/ avoidance behaviour of avatars. This study further validates the findings of a previous study conducted by Dad et al. (2018), which examined the impact of music in 3-dimensional retail settings with the help of convenience sampling.

Limitations are fundamental aspect of all research endeavours, and this particular study is not exempted from this reality. The scope of this study was restricted to Fashion & Style apparel stores in order to assess the conceptual model. Therefore, future research studies may investigate various other categories of 3D VRR stores. Moreover, the sample size of 140 participants, collected over a period of two and a half months, may be considered relatively small in representing the entire population of the Virtual World. And therefore, the findings of this study may not be certainly generalised. To address this limitation, it is recommended to increase the sample size and allocate more time for data collection. Additionally, this study examined 3D VRR stores without any manipulation however, it is assumed that the manipulation of 3D VRR atmospherics has the potential to effect the overall results. This study investigated only 3 x dependent variables, which are arousal, pleasure, and behaviour, however, previous retail studies have investigated several dependent variables such as satisfaction, attitudes, and other related variables. And hence it is recommended that future research may not rely on pleasure, arousal and approach/avoidance behaviour as primary determinants.

## **7 MANAGERIAL IMPLICATIONS**

Academic scholars in the field of retail have an extraordinary fascination in investigating the impact of store atmospherics on shoppers' buying behaviours. Since 1974, scholars have been conducting extensive studies of brick-and-mortar stores. Moreover, multiple studies have been conducted on online retail atmospherics since their inception. The advent of new Volkswagen models brings out an innovative retail encounter in the form of 3D VRR stores, which present an array of opportunities for businesses, researchers, and shoppers. Therefore, this study emphasises the need of adopting a strategic outlook when considering the potential benefits and limitations of 3D VRR stores for existing retail operations. The potential of 3D VRR stores must not be underrated. The significant influence of colour choices in 3D VRR environments on avatars' arousal and pleasure recommends a potential impact on avatars' buying responses. Hence, the findings of this study indicate that it is crucial for 3D retailers to pay careful attention while designing their virtual reality stores inside the any virtual worlds. Findings of this study determines that colours possess significant effect as an environmental cue for inducing approach behaviour. This study demonstrated that colours had a significant effect on the arousal and pleasure experienced by avatars, as well as their subsequent shopping activity. Nevertheless, this study revealed that wrong choice of colours in 3D VRR stores might potentially exert a negative effect on the emotional states and behavioural responses of avatars. It is advisable for future researchers and entrepreneurs within this realm to investigate the effect of different colour schemes on avatars' emotions and behaviours.

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