An investigation of visual comprehension in memory for 360-degree video advertisements amongst adolescents

Nirma Sadamali Jayawardena
Department of Marketing, Griffith University, Gold Coast Campus, Southport, Australia and
Department of Marketing, O P Jindal Global University, New Delhi, India, and
Mitchell Ross, Sara Quach and Debra Grace
Department of Marketing, Griffith University, Gold Coast Campus, Southport, Australia

Received 27 October 2021
Revised 17 May 2022
1 July 2022
Accepted 12 September 2022

Abstract

Purpose – The purpose of this study is to investigate visual comprehension in memory for 360-degree video advertisements amongst adolescents under single and repeated viewing conditions.

Design/methodology/approach – This study explored visual comprehension in memory for 360-degree video advertisements using the theoretical assumptions of the social psychology theory of social information processing by Wyer (2003). The authors conducted two experiments over a timeline of three months. In the first experiment, participants watched the 360-degree video advertisement once, and after one week, the same set of participants watched the same advertisement again. The theoretical assumptions in the comprehension unit were used to design the experiments and to explore visual comprehension in memory for 360-degree video advertisements. The data were collected using surveys and interviews through an experimental research design approach. NVivo software was used to analyse the data.

Findings – This study found that while female participants were able to comprehend colours in the visuals better, male participants were better able to comprehend facial expressions presented in the visuals. Further, both female and male participants were able to comprehend locations within the advertisement visuals. It was found that participants understood the plot or the story of the advertisement better after the second viewing than after the first viewing.

Practical implications – The two main contributions from this study are as follows: from a theoretical perspective, the application of a social psychology theory for the advertising sector enables us to gather more insights about the social cognition stages of a human mindset such as information retrieval, judgement, decision making, goal stimulation and short- and long-term memory. In doing so, this study not only explored adolescents' visual comprehension memory of 360-degree video advertisements, but it also contributed to the theory of social information processing by Wyer (2003) by exploring consumer visual comprehension memory. From a practical perspective, the findings of this study provide a solid foundation for future advertising firms or agencies, marketers, and salespeople on how to design effective advertisements using 360-degree video versions in a way that appeals to consumer visual memory.

Originality/value – This paper can be considered as amongst the first studies which combine social psychology with advertising to investigate visual comprehension memory for 360-degree video advertisements amongst adolescents.

Keywords Adolescents, 360-Degree videos, Advertising, Visual comprehension, Panorama effect

Paper type Research paper

1. Introduction

The marketing industry is continuously changing due to technological innovations and innovative digital channels such as e-mail marketing, pay-per-click advertising, search engine

The author would like to acknowledge Griffith University for providing a Griffith University International Postgraduate Research Scholarship and the Australian Government Research Training Program Scholarship in 2019 to pursue the author's PhD studies.

Asia Pacific Journal of Marketing and Logistics

1355-5855
DOI 10.1108/APJML-10-2021-0786

optimisation (SEO), social media marketing and affiliate marketing (Habig, 2016). In recent decades, evolutionary advancements in technology such as 360-degree video technology, augmented reality, virtual reality, mixed reality, artificial intelligence, blockchain technology, 3-D and 2-D videos have become innovative approaches to be used in the marketing field (Habig, 2016; Feng, 2018). Considered as immersive or spherical videos, 360-degree videos are video recordings that consist of views in every direction which are recorded at the same time (Habig, 2016). These photo-shoots are conducted by using an omnidirectional camera or a collection of cameras (Feng *et al.*, 2019; Wedel and Pieters, 2000). During playback on a normal flat display, the viewer has control of the viewing direction just like in a panorama (Feng *et al.*, 2019; Shen *et al.*, 2020). A 360-degree video can show the stories more interactively (Shen *et al.*, 2020; Feng, 2018). Literature suggests that 360-degree videos may increase audience engagement better than traditional videos (Feng, 2018; Feng and Mueller, 2019). The ability of 360-degree videos to be used as a storytelling tool is based on their capability to convey the complete context of the scene, along with what is happening around it (Feng and Mueller, 2019).

2. The role of visual comprehension memory in advertising research

Picture messages can convey information more effectively than textual messages (Geise and Baden, 2015). The visuals in a product save buyers' time and effort as they can learn more about products or services without having to review the details in the webpage (Wu *et al.*, 2016). Due to this advertising strategy, advertisers began using many complex pictures to advertise their products, but this created the serious problem of visual overload (Wu *et al.*, 2016). As a result, buyers were unable to locate and process product information (Mazzoni *et al.*, 2014). To address this problem, some sellers displayed only the product image to attract the attention of buyers (Wu *et al.*, 2016).

According to McNeal and Ji (2003), when children think of cereal products, it is not just a list of brand names that they remember, but rather an elaborate symbolic environment composed of visuals and verbal codes that makes them recall the brand name of the cereal product. Another example is the use of visual animations to enhance recognition effects for banners (Kuisma *et al.*, 2010) and the use of advertising messages, featuring nature images to enhance memory (Hartmann *et al.*, 2013). Several researchers have also studied the positive influence of visual memory on advertising and the impact on purchasing behaviour in various ways. Huettl and Gierl (2012) reported that visual artwork used in advertisements and on packaging can influence perceptions of luxury and influence attitudes towards the product. Krishna *et al.* (2016) found visual aesthetics to be a critical factor affecting the effectiveness of the advertisement, as the images in the viewer's mind play a large role in affecting their evaluations of the advertisement. The visual is an important element of web advertising success, as it plays an important role in forming online purchase intentions. Shaouf *et al.* (2016) observed that web advertising's visual cues influence consumers' purchasing intentions through advertising attitudes and brand attitudes. Therefore, the importance of consumer visual comprehension memory for advertising plays a major role as it is necessary to organise the visuals to advertise products without creating visual overload issues (Wu *et al.*, 2016; Wedel and Pieters, 2008).

2.1 Consumer visual comprehension memory and repeated video viewing

Pechmann and Stewart (1988) described advertising repetition effects as the differential effects of each successive advertising exposure within a sequence of exposure and visual comprehension memory and repeated viewing are closely related. In general, it can be assumed that objects that are fixated for a longer period of time will also be remembered better than objects that are fixated for a shorter period of time (Tatler *et al.*, 2005).

An experimental investigation using a new brain imaging technique, termed steady-state probe topography, investigated whether patterns of brain activity in the left or right frontal hemispheres could identify which frames from new TV commercials would be recognised by consumers one week later (Rossiter *et al.*, 2001). Findings revealed that video scenes displayed on screen for 1.5 s or longer were better recognised as it stores in the left frontal hemisphere in the human brain (Rossiter *et al.*, 2001). Therefore, visual content that stimulates left-brain activity creates memorable advertising.

Similarly, some researchers have identified the effects of repeated viewing on human comprehension memory in various settings such as education, psychology, and marketing. For example, in the education context, Silverman (2013) revealed repeated viewing as a factor which improves vocabulary learning amongst school children. Skouteris *et al.* (2007) explored the effects of repeated viewing on comprehension of explicitly and implicitly presented information in an animated movie and found that repeated viewing facilitated children's explicit comprehension of the central character in the animated movie. In the marketing context, it has been argued that repeated viewing gradually makes initially incomprehensible stimuli understandable, increasing children's level of engagement and their ability to process information about the story (Skouteris *et al.*, 2007). The first empirical study to investigate the effects of repeated viewing on young children's comprehension of television was conducted by Sell *et al.* (1995) who found that repeated viewing of the "Sesame Street" video tapes improved pre-school children's ability to comprehend the plot (Sell *et al.*, 1995).

In psychology research, repeated viewing of a video about a burglary created high confidence amongst viewers in their memory about the suggested events of the video (Zaragoza and Mitchell, 1996). Cox and Cox (2002) examined the effects of repeated exposure on consumers' aesthetic preferences and how this effect may vary depending on the nature of a product's visual design. The results suggested that preferences for visually complex product designs tend to increase with repeated exposure, while preferences for visually simple product designs tend to decrease with repeated exposure.

2.2 Importance of 360-degree video advertising

Firstly, research conducted by Google proved that 360-degree videos contribute a five-times higher click-through rate, and more repeated views (because viewers can have a different experience each time they watch) than a standard video (Helm, 2020). Secondly, Watson (2017) found that organisations are now investigating the effectiveness of 360-degree video versions due to high audience engagement and revenue generation. Further, the success of 360-degree video advertisements is being driven by achieving 29% more views than the same videos using a traditional video format (Feng, 2018). Forer (2018) found that these videos have a higher click-through rate compared to standard videos. As a result, brands across different industries are experiencing significant success via their use of 360-degree video advertisements (Forer, 2018). Consequently, this study's investigation of consumer visual comprehension memory of 360-degree video advertisements under two main conditions namely, single viewing and repeated viewing points to two gaps in current research, as shown in Table 1.

Further, a proper theoretical framework is necessary to develop the experiments in identifying the relationship between 360-degree video advertisements and consumer visual comprehension memory for adolescents. The next section discusses the overview of the theoretical framework in designing the experiments.

3. Theoretical background

A theory of social information processing by Srull and Wyer (1980), has been iterated many times, in 1986, 1989 and 2003 (Van Lange *et al.*, 2012). The initial version of this theory consists

of a conceptualisation of information processing amongst human beings. This theory focusses on several aspects of the social cognition stages of human beings; for example, how people process, store and apply information about other people and social situations (Srull and Wyer, 1989; Hong and Wyre, 1990; Wyer and Martin, 1986). Moreover, this theory is also a useful theoretical framework for conceptualising and integrating the deliberate and automatic processes that occur at different stages of cognitive functioning, including comprehension, memory storage, retrieval, inference, judgement, decision making and output generation (Van Lange *et al.*, 2012).

The latest version of the theory, which was revised in 2003, will be used in this study. This theory provided a framework by integrating the phenomena identified in social cognition areas such as comprehension, organisation of information in memory, inference, and the generation of overt responses amongst consumers (Van Lange *et al.*, 2012). It consists of three major memory units, four special purpose processing units, and an executor that directs the flow of information between these units (Wyer, 2003). Arrows denote the direction of transmission of cognitive material between these units. The three major memory units include the workspace, the permanent storage unit, and the goal specification box (Wyer, 2003). The four processing units include the comprehender, encoder, inference maker and response selector (Wyer, 2003).

3.1 Theoretical constructs

The system architecture consists of rectangles that represent the storage units, and ovals or circles representing processing units (Wyer, 2003) (refer to Figure 2). Table 2 presents the definitions and meanings to facilitate the understanding of the technical terms in this theory.

Authors have used the theoretical assumptions of the processing unit of comprehender (Wyer, 2003). The first section of the "workspace" unit stores information that has recently been transmitted to it by the "comprehender". In designing the experiments, the authors used the theoretical assumptions of the first unit which denotes the temporary visual comprehension memory of a person (see Figure 1).

4. Research methodology

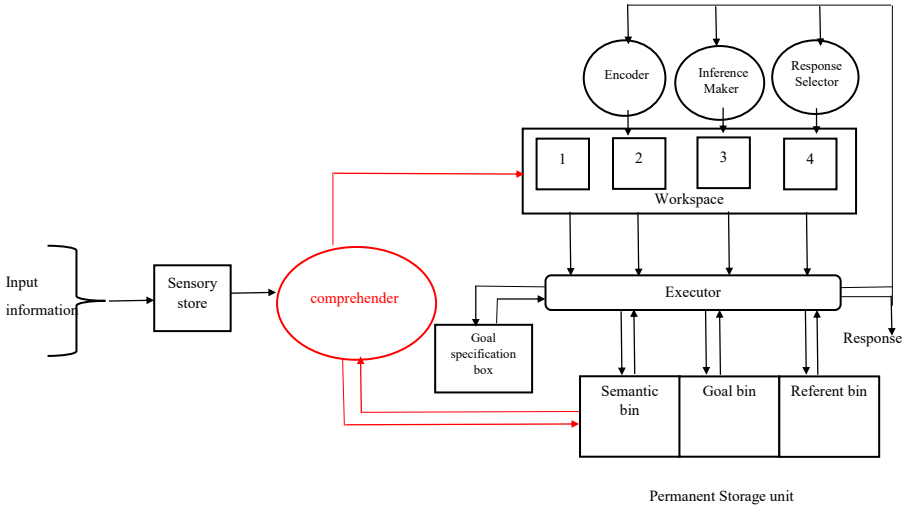
The visual memory comprehension assessment was developed based on the theoretical assumptions of comprehender. The data were collected using 20 participants through the non-probability sampling method of snowball sampling. For example, Morse (2000) recommended 20 to 30 interviews as a suitable number in experimental research with two to three interviews per individual. The main reason for selecting the participants using snowball sampling is that the participants will be recruited through the "friends of friends" approach (Feng *et al.*, 2019; Pieters *et al.*, 2010). In the first experiment, participants watched the 360-degree video advertisement using Google Cardboards once. Later they were invited for the second experiment after one week to watch the same 360-degree video advertisement

Table 1. Summary of studies on the effects of 360-degree video advertisements

Study gap	Research question
Limited research focussed on consumer visual comprehension memory of 360-degree video advertisements amongst adolescents under single viewing conditions	RQ1: What are the visual comprehension memory effects of 360-degree video advertisements amongst adolescents under single viewing conditions?
Limited research focussed on consumer visual memory of 360-degree video advertisements amongst adolescents under repeated viewing conditions	RQ2: What are the visual comprehension memory effects of 360-degree video advertisements amongst adolescents after repeated viewing?

Technical term	Meaning
Input information	Input information is the raw data that are initially encoded by the Comprehender to semantic concepts
Sensory store	The sensory store initially stores the information which is captured by the five senses of human beings such as sight, smell, taste, touch and hearing
Comprehender	The Comprehender is an initial comprehension device that interprets input information to verb, noun and adjective concepts
Workspace	This unit is a temporary storage unit and consists of four sections
Executor	The activation of the latter units is governed by an Executor, which directs the flow of information between processing units and storage units
Permanent storage unit	This unit is assumed as long-term memory storage
Goal specification box	Executor retrieves a relevant goal schema from permanent storage and deposits it in the goal specification box
Encoder/organizer	Encoder processes high-order interpretations of information and forms mental representations consisting of several features
Inference maker	Inference maker combines the implications of information to form a subjective judgement
Response selector	Response selector transforms subjective inferences into a meaningful response

Table 2. Technical terms and definitions of this study

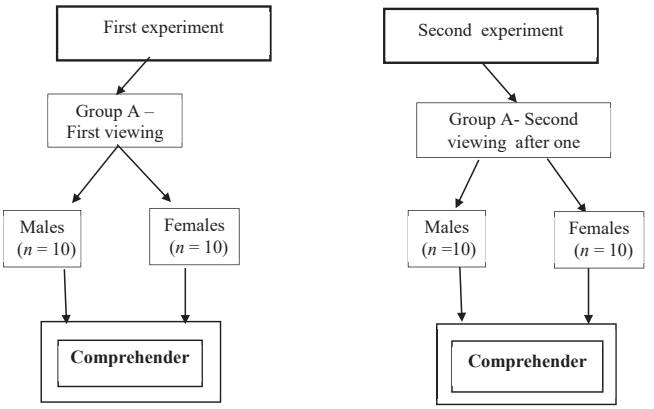


Source(s): Wyer (2003) Social comprehension and judgment: The role of situation models, narratives, and implicit theories: Psychology Press

Figure 1. Metaphorical representation of social information processing theory of Srull and Wyer (1980)

again (Feng *et al.*, 2019; Pieters *et al.*, 2010). A semi-structured interview was used to collect the data and the thematic results were analysed using NVivo software.

The first step was to search on YouTube for available 360-degree video advertisements (Feng *et al.*, 2019). This was done carefully by ensuring that while ad format is different, other factors (e.g. story plot, characters and visual elements) remain the same (Feng *et al.*, 2019; Shen *et al.*, 2020). From the eight available video advertisements which had 360-degree



Source(s): Jayawardena (2022)

Figure 2.
Diagram of the data analysis phase the study

counterparts (Lipton Magnificent Matcha, Columbia Sportswear, Mercedes-Benz, Nescafe, BMW, Expedia and Infiniti) the Lipton Matcha advertisement was selected. The "Magnificent Matcha Tea" advertisement promoted a new tea product and had a higher number of visuals than the other video advertisements, such as Columbia Sportswear, Nescafé, Expedia.com, BMW, Mercedes-Benz, Expedia and Infiniti which fall under the definition of visual memory investigation of this study (e.g. human visual memory activation is higher for novel scenes than repeated scenes due to the activation of hippocampal regions in the brain Köhler *et al.* (2002)) (see Table 3).

Figure 2 further shows the diagram of the data analysis phases of the first and second experiments.

4.1 Stages of data analysis using NVivo QSR

A variety of methods have been proposed for the analysis of data using QSR NVivo. It was found to be useful to use O'Neill's (2013) toolkit for this research. Table 4 presents the stages followed in analysing the data.

(1) Stage 1: Participants' demographic information with datasets

Designing a database for the research study is the first step of data analysis with NVivo (O'Neill, 2013). The experiments took around one to two hours in total to complete for each

Table 3.
The sample YouTube video advertisement

Video name	360-Degree video version
Lipton, "New Lipton Magnificent Matcha Takes You Inside the Cup"	https://www.youtube.com/watch?v=S_hpD7teoow

Table 4.
Stages of NVivo QSR toolkit

Stages of NVivo QSR toolkit	The steps involved in each stage of the process
Stage 1: Descriptive	Participants demographic information with datasets
Stage 2: Topic	Cluster Analysis of coded material using word similarity
Stage 3: Analytic	Analytic using content analysis through word cloud and query results

participant. First, the participant was asked to complete the first few sections of the information sheet to determine whether they had watched this advertisement before. If the participants had watched it before, then they were identified as disqualified. The 20 participants included 10 males and 10 females. The demographic details of the participants are presented in Table 5 as follows.

As demonstrated above, from the 20 participants, 60% participants were between the age group of 18–20 years and 40% were between 16–18 years. These participants represented different nationalities including Sri Lanka (25%); Denmark (5%); Germany (5%); Bangladesh (5%); China (5%); Turkey (5%); Pakistan (5%); Africa (5%); India (10%). The primary data include the interview transcripts with voice recordings (O'Neill, 2013). In this stage, the data transcripts were initially divided into two parts—females and males. Then these transcripts were further divided based on the comprehension category.

Stage 2: Cluster Analysis of coded material using word similarity

The second stage of the process involved developing themes based on the transcripts. It also included the coding of interview material and the grouping of related concepts under the one heading called a "node", which was used to analyse the data later (Hutchison *et al.*, 2010). Further, cluster Analysis of coded material using word similarity was used to identify the themes (O'Neill, 2013).

Stage 3: Analytics using content analysis through word cloud and query results

Content analysis has been considered a research methodology that observes textual data for patterns to extract the meaning from the text (Gray and Densten, 1998). Some of the methods include creating hierarchies by merging nodes; visualising data, such as cluster analysis and using queries and word cloud maps (Hutchison *et al.*, 2010; O'Neill, 2013). This study used query result analysis and word cloud analysis to analyse the derived themes.

Demographic details	Age group	Gender	Nationality
P 1	16–18 years	Male	Sri Lanka
P 2	18–20 years	Male	Germany
P 3	16–18 years	Male	India
P 4	16–18 years	Male	Bangladesh
P 5	18–20 years	Male	Sri Lanka
P 6	18–20 years	Male	Africa
P 7	18–20 years	Male	China
P 8	18–20 years	Male	Malaysia
P 9	18–20 years	Male	Australia
P 10	16–18 years	Male	Australia
P 11	16–18 years	Female	Denmark
P 12	16–18 years	Female	Sri Lanka
P 13	18–20 years	Female	Sri Lanka
P 14	18–20 years	Female	Turkey
P 15	18–20 years	Female	Australia
P 16	18–20 years	Female	Australia
P 17	16–18 years	Female	Sri Lanka
P 18	16–18 years	Female	Sri Lanka
P 19	16–18 years	Female	India
P 20	16–18 years	Female	Pakistan

Note(s): *P 1 = Participant 1

Table 5. Demographic details of the 20 participants

4.2 Results of the experiment 1

The next section presents the NVivo thematic analysis for visual comprehension memory. This determines the ability of the participants to comprehend the information contained within the visuals presented in the 360-degree video advertisement under single viewing time. Each participant will be provided with a separate Google Cardboard to view the 360-degree video advertisement under both single and repeated viewing conditions. The thematic results were presented separately based on the female and male participants.

4.2.1 Thematic analysis of female participants under visual comprehension. Initial themes were developed from the node cluster diagram, and Figure 3 illustrates the node cluster diagram using the word similarity approach (Di Gregorio, 2000; Dollah *et al.*, 2017; Hutchison *et al.*, 2010; O'Neill, 2013).

Based on the node cluster diagram above, the coding in-between the concepts of colours such as blue, yellow and red highlights the colour detection node more than the facial expressions. Based on treemap analysis, the density of each concept was checked to label the theme accurately. Figure 4 illustrates the tree map analysis (Di Gregorio, 2000; Dollah *et al.*, 2017).

According to the query results, female participants under the 360-degree video viewing conditions comprehended information in the advertisement regarding locations and colours (see Table 6).

Some of the NVivo findings on these themes are as follows (see Table 7).

Based on the word cloud NVivo QSR analysis, the themes of colour comprehension and visual memory on locations can be further justified (refer Figure 5).

4.2.2 Thematic analysis of male participants under visual comprehension. Initial themes were developed from the node cluster diagram as follows. Figure 6 illustrates the node cluster diagram using the word similarity approach (Di Gregorio, 2000; Dollah *et al.*, 2017; Hutchison *et al.*, 2010; O'Neill, 2013).

Based on the above node cluster diagram, the coding in-between the concepts of facial expressions and locations can be further justified. The coding on colours is less in comparison to the coding on facial expressions. Based on treemap analysis, the density of each concept was checked to label the theme accurately. Figure 7 illustrates the tree map analysis (Di Gregorio, 2000; Dollah *et al.*, 2017).

According to the query results, male participants under the 360-degree video viewing conditions comprehended information in the advertisement regarding locations and facial expressions (see Table 8).

Some of the NVivo findings on these themes are as follows (see Table 9).

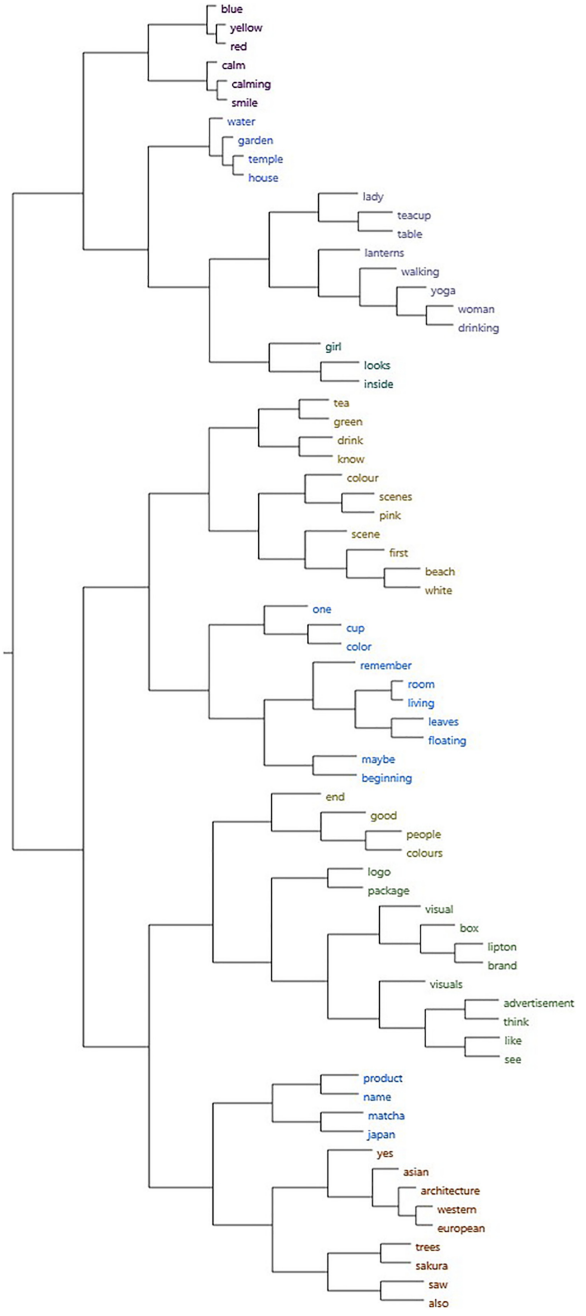
Based on the word cloud NVivo QSR analysis, the themes of facial expressions and visual memory on locations can be further justified (refer Figure 8).

Overall results indicated that under single viewing conditions, both female and male participants were able to comprehend the colours, locations and facial expressions within the visuals of the advertisement. While female participants were able to comprehend colours in the visuals better, male participants were better able to comprehend facial expressions presented in the visuals.

4.3 Results of the experiment 2

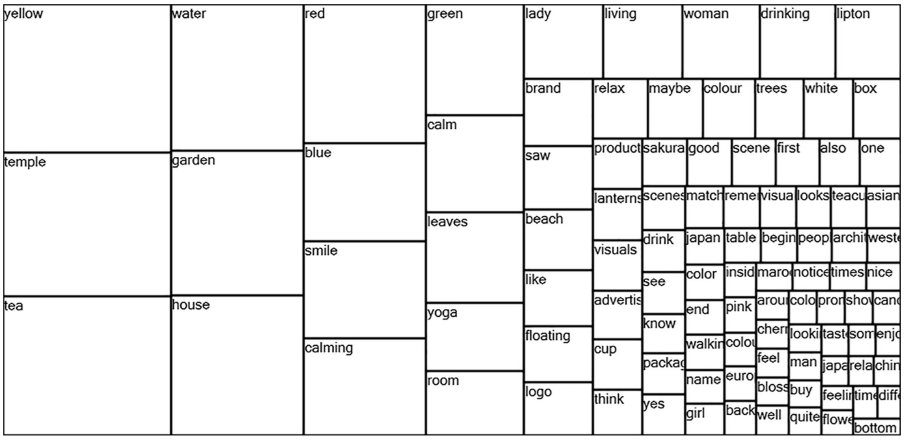
Experiment 2 of this study had the same design as experiment 1. The same set of participants were invited to watch the same 360-degree video advertisement using Google Cardboard under repeated viewing conditions.

4.3.1 Thematic analysis of male participants under visual comprehension. Initial themes were developed from the node cluster diagram as follows. Figure 9 illustrates the node cluster diagram using the word similarity approach (Di Gregorio, 2000; Dollah *et al.*, 2017; Hutchison *et al.*, 2010; O'Neill, 2013).



Source(s): Jayawardena (2022)

Figure 3.
The node cluster diagram using the word similarity approach



Source(s): Jayawardena (2022)

Figure 4.
Treemap analysis

Table 6.
Thematic classification based on the treemap analysis and node cluster diagram

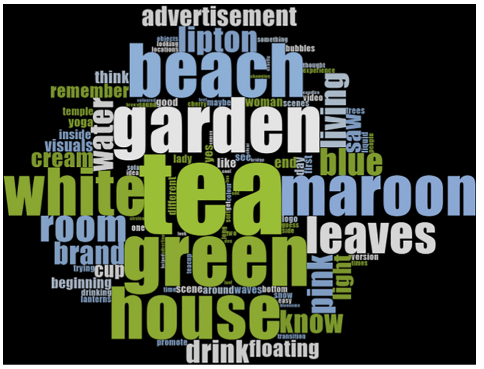
Themes	Concepts derived from the node cluster diagram	Concepts derived from tree map analysis
Colour detection	Blue; yellow; red; green; colour; pink	Yellow; blue; red: colour; pink; white
The visual memory of locations	Water; garden; temple; house; room; living	Temple; garden; house; leaves; room; beach; living

Table 7.
NVivo query findings on colour comprehension and locations amongst female participants

Theme	Codes	NVivo QSR query results
Colour detection	Green	* Beginning I noticed green leaves swirling around . . . (P7) Good and happy colours and calming colours. They are the most noticeable colours for a tea as it is yellow. . . ..(P2)
	Maroon	* A lady was there wearing a maroon colour blouse . . ..(P4)
	White	* The living room walls were white, and I saw some white colour curtains . . ..(P11)
	Blue	* The sky was clear blue with some white clouds . . . .(P3)
The visual memory of locations	Garden	* Garden with a red colour bridge . . ..(P12) * First tea liquid, then the garden and then some lanterns and . . . .(P13)
	Beach	*I would say that it is a white beach . . . .(P18) * The order of the visuals is first the leaves, water, garden, temple, beach and living room . . . .(P8)
	Living room	* In the end, I saw the living room . . . .(P8) *I was in a living room, and it was an ordinary living room . . ..(P14)

Based on the above node cluster diagram, the coding in-between the concepts of colour detection, locations and facial expressions can be further justified. For example, the concepts including "garden", "temple", "beach", and "room" can be classified separately as one main theme of locations. Based on the treemap analysis, the density of each concept was checked to label the theme accurately. Figure 10 illustrates the tree map analysis as follows (Di Gregorio, 2000; Dollah *et al.*, 2017).

The concepts such as "story", and "plot" indicated that in the second viewing, participants were able to understand the story of the advertisement better and they also noticed many



Source(s): Jayawardena (2022)

Figure 5.
NVivo QSR word cloud analysis –360-degree video version (female participants)

locations such as "temple", "beach" and a "garden". Based on treemap analysis and the node cluster diagram, these themes can be further justified as follows (see Table 10).

Some of the NVivo findings on these themes are as follows (see Table 11).

Based on the word cloud NVivo QSR analysis, the themes of facial expressions, visual memory on locations and storytelling techniques can be further justified (refer Figure 11).

4.3.2 Thematic analysis of female participants under visual comprehension. Initial themes were developed from the node cluster diagram as follows. Figure 12 illustrates the node cluster diagram using the word similarity approach (Di Gregorio, 2000).

Based on the above node cluster diagram, the coding in-between the concepts of colour detection, locations, facial expressions and storytelling techniques can be further justified. For example, the concepts including "garden", "temple", "beach" and "room" can be classified separately as one main theme of locations. Figure 13 illustrates the treemap analysis as follows (Di Gregorio, 2000; Dollah *et al.*, 2017).

Based on treemap analysis and the node cluster diagram, the themes can be further justified as follows (see Table 12).

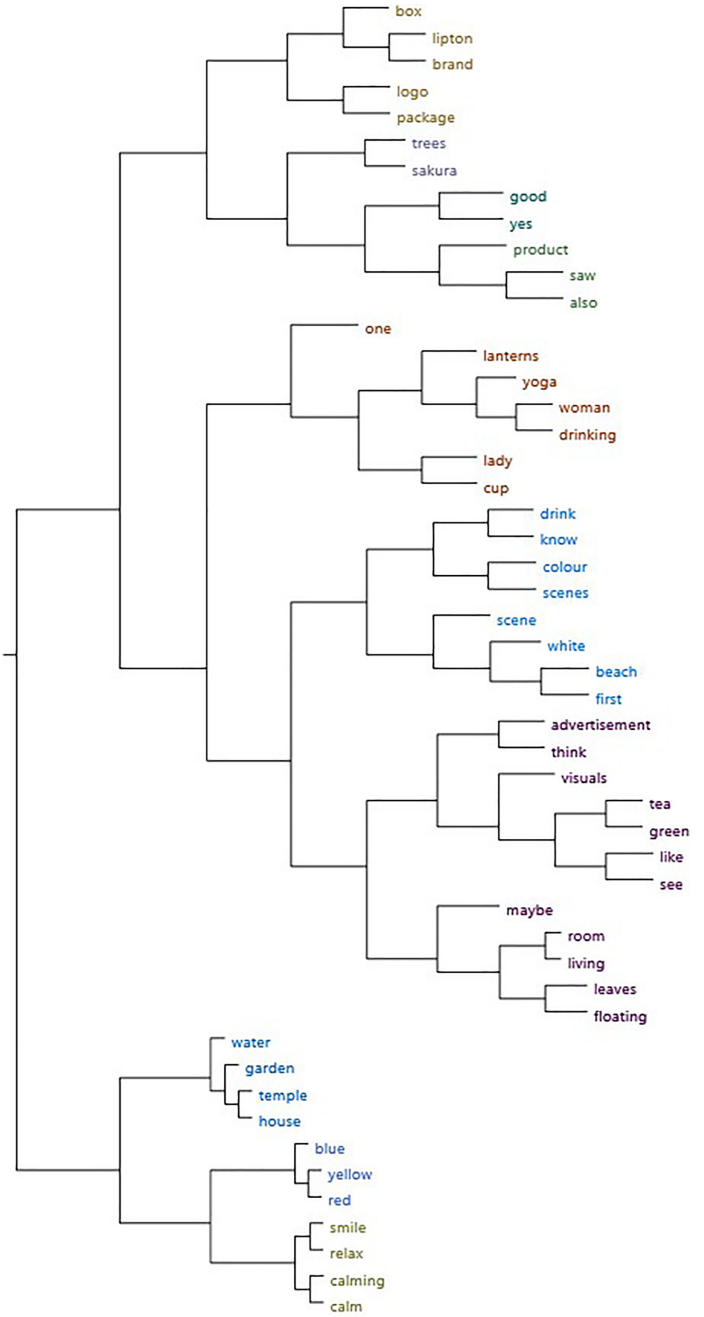
Some of the NVivo findings on these themes are as follows (see Table 13).

Based on the word cloud NVivo QSR analysis, the themes of facial expressions, visual memory on locations and storytelling techniques can be further justified (refer Figure 14).

Overall results indicated that, while female participants were able to comprehend colours in the visuals better, male participants were better able to comprehend facial expressions presented in the visuals. Further, both female and male participants were able to comprehend locations within the advertisement visuals. It was found that participants understood the plot or the story of the advertisement better after the second viewing than after the first viewing.

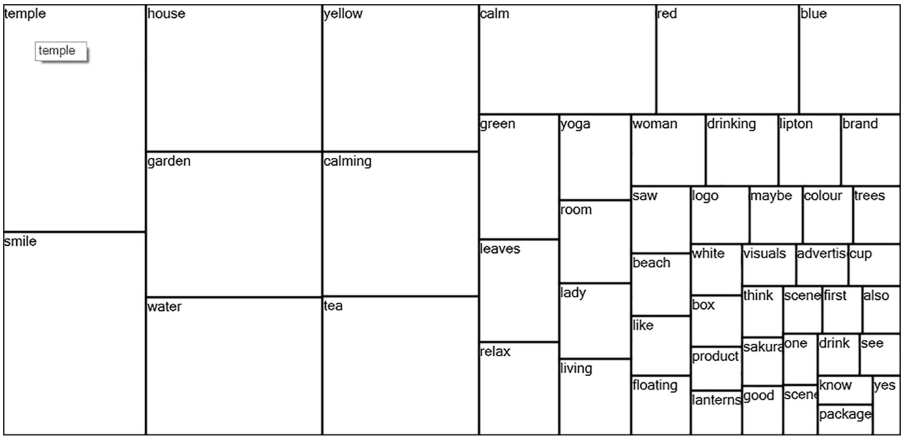
5. Discussion of the findings

In experiment 1 and 2, it was identified that colour detection, facial expressions, visual memory of locations and plot of the advertisement were the main thematic findings. When considering the comprehension of the visuals, female participants were able to comprehend the colours and the locations. They also understood the plot of the advertisement better after viewing the advertisement for the second time. Based on the thematic analysis, it was identified that some of the colours comprehended were green, maroon, yellow and white. Under the second viewing, participants were able to notice more locations such as temple, beach, garden, house and water which were not noticed in the first viewing. In contrast, male participants comprehended facial expressions in the visuals better while female participants better comprehended colours within the visuals. Based on the thematic analysis, it was



Source(s): Jayawardena (2022)

Figure 6.
The node cluster diagram using the word similarity approach



Source(s): Jayawardena (2022)

Figure 7.
Treemap analysis

Themes	Concepts derived from node cluster diagram	Concepts derived from tree map analysis
Facial expressions	Good; smile; relax; calming; calm	Calming, smile, calm, relax
The visual memory of locations	Trees; Sakura; lanterns; beach; room; living; water; garden; temple; house	Temple; garden; house; water; room; visuals

Table 8.
Thematic classification based on the tree map analysis and node cluster diagram

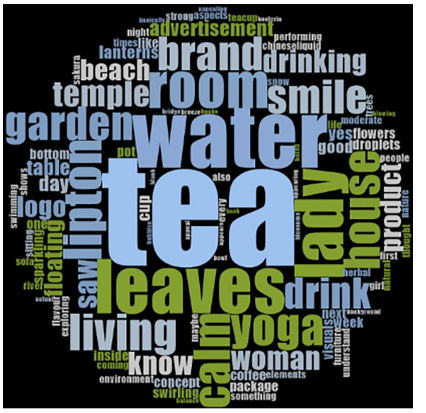
Theme	Codes	NVivo QSR query results
Facial expressions	Calm	* Tea leaves and water create a more tranquil environment . . . . . .(P12)
	Smile	* With a cup of tea in her hand, the lady smiles . . . . . .(P20)
		* Lady sipping tea shows the relaxation and happiness . . . . . .(P13)
Visual memory for locations	Water	* At the start underwater feeling and then the logo of Lipton appeared . . . .(P16)
	House	* Some breeze and inside the house are a good matching time for a tea I guess . . . .(P8)
		I saw some furniture inside a house . . . . . .(P2)
	Garden	* That garden had some trees and also a red bridge . . . .(P2) . . .
		* Some Sakura flowers were there in the garden . . . .(P2)
	Temple	* Next, I saw a Chinese temple . . . . . .(P2)

Table 9.
NVivo query findings on facial expressions and locations amongst male participants

identified that some of the identified facial expressions were happiness and relaxation. Under the second viewing, both male and female participants were able to understand the story of the advertisement better.

5.1 Colour detection in visuals

When considering colour detection, it was found that female participants noticed more colours in the visuals than male participants. Furthermore, the 360-degree video version permitted participants to notice more colours within the visuals. Based on the literature, this can be justified mainly based on two main aspects. Firstly, 360-degree videos are created



Source(s): Jayawardena (2022)

Figure 8.
NVivo QSR word cloud analysis –360-degree video version (male participants)

using a collection of cameras with limited scenes that lead viewers to concentrate on a few significant objects or items of a complex scene when it comes to their visual system (Tenic, 2018; Feng *et al.*, 2019). This type of behaviour creates a visual attention mechanism that leads humans to be attracted towards colours and high contrast resolution in the videos due to limited views in the scene. This allows participants to focus more on the colours and high contrast resolution within the videos (Tenic, 2018; Feng *et al.*, 2019).

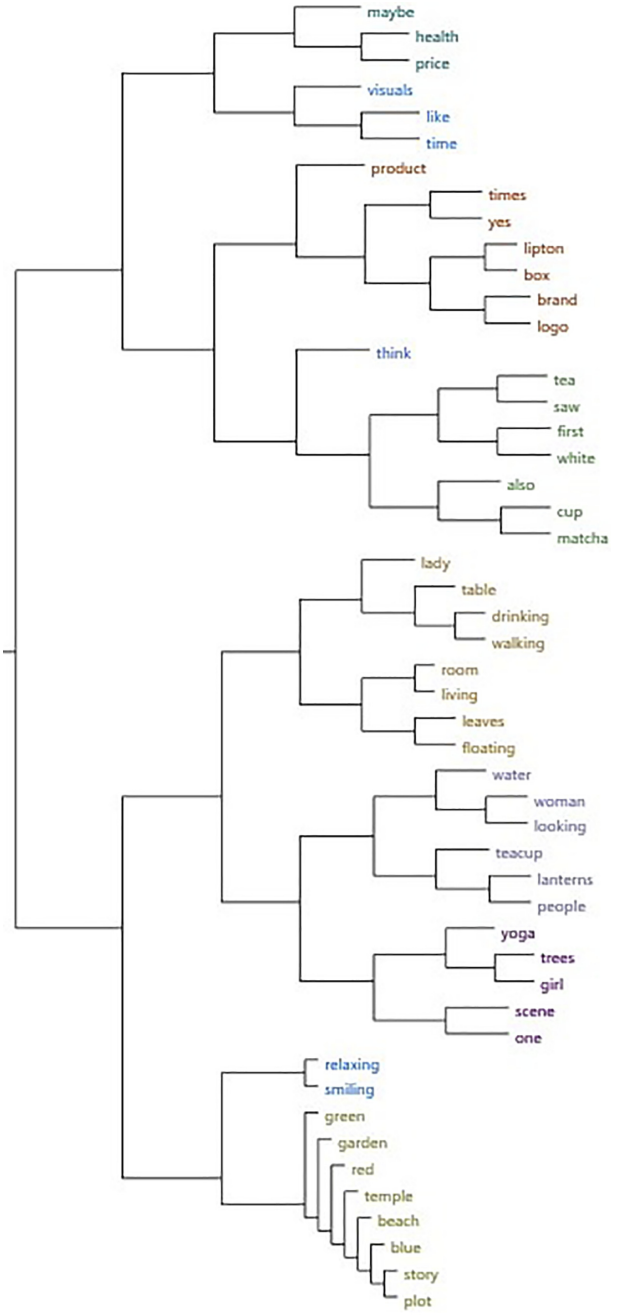
Secondly, in a 360-degree video, the audience does not have the same view (Tenic, 2018). The video begins with a specific angle of the scene and viewers are required to interact with it to move around and see everything (Tenic, 2018). This leads viewers to detect more colours owing to the higher eye movements in 360-degree videos (Tenic, 2018). Studies have shown that eye movements are closely associated with cognitive processes such as attention, memory and decision making (Xu *et al.*, 2020; Zhu *et al.*, 2018). Consequently, as a visual arrangement strategy, advertising designers can enhance colour detection in visuals by integrating visuals taken from a collection of cameras and by increasing eye movements when advertising products for females.

5.2 Facial expressions in visuals

When considering facial expressions in visuals, it was identified that in advertisements, emotional appeal is prevalent (Zhou *et al.*, 2021). Consequently, the theme of facial expressions was categorised by the authors based on the key concepts of calmness, relaxation and happiness. In advertisements, displaying emotions arouses more attention and generates better marketing outcomes (Higgins and Lauzon, 2003). Consumers' attitudes and buying habits are influenced by their emotions (Higgins and Lauzon, 2003). In the 360-degree video condition, it was identified that male participants noticed facial expressions more often than females during the repeated viewing conditions. It is suggested that to promote products for men, it is important to add some facial expressions in the visuals to get the attention. These findings are in line with previous works by (Mueser *et al.*, 1984; Preston and De Waal, 2002).

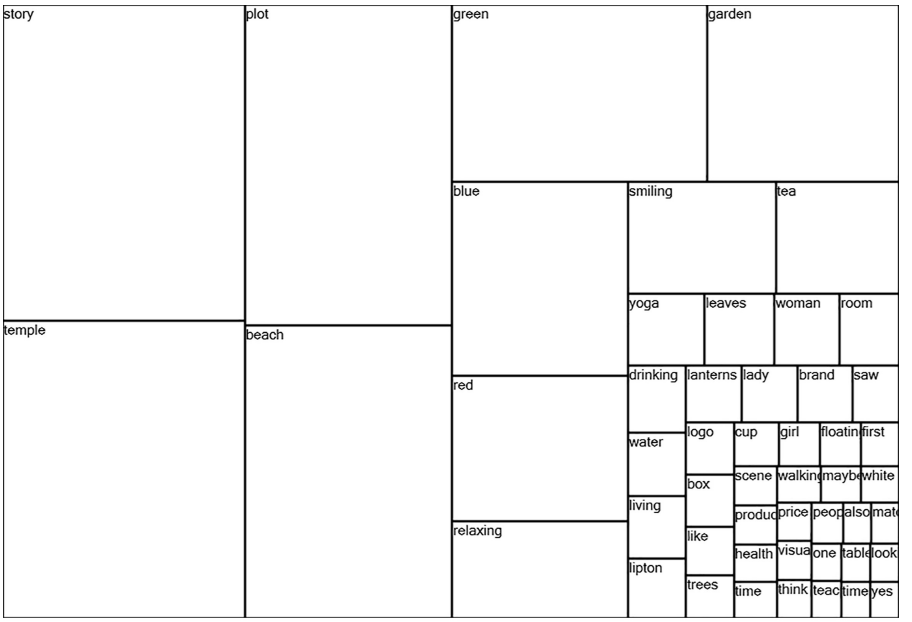
5.3 Visual memory on locations

It is common practice to advertise based on locations to provide a variety of atmospheres for customers coming from different countries (Banerjee and Roy Dholakia, 2012; Kurtz *et al.*, 2021). In terms of visual comprehension strategies, it has been found that larger images



Source(s): Jayawardena (2022)

Figure 9.
Node cluster diagram using word similarity approach



Source(s): Jayawardena (2022)

Figure 10.
Treemap analysis

Themes	Concepts derived from node cluster diagram	Concepts derived from tree map analysis
Facial expressions	Relaxing, smiling, looking	Smiling, relaxing
The visual memory of locations	Room, living, temple, garden, beach	Temple, beach, garden, room
The plot or storytelling	Story, plot, scene	Story, plot

Table 10.
Thematic classification based on the tree map analysis and node cluster diagram

Theme	Codes	NVivo QSR query results
Visual content with locations	Room	It was a room I do not know whether it is a living room or not. (P3)
	Beach	Blue sky and sunny time on the beach (P6)
	Garden	I saw some Sakura flowers in the garden (P16)
	Temple	I saw some flying lanterns in the temple. I am not sure whether it is two scenes or one. The transition was very quick (P8)
Facial expressions	Smiling	She was smiling . . . looks like she had a good day (P11)
	Relaxing	The green leaves and the pot and then the brand logo mixed all things up which makes a relaxing atmosphere (P12)
Storytelling techniques	Story	Yes, the story is very clear this time. So, it is about tea production (P7)
	Leaf	Maybe the tea leaf indicates the tea production to tea packaging process (P9)

Table 11.
NVivo query findings amongst male participants

occupying at least two-thirds of the screen are more likely to be noticed (Banerjee and Roy Dholakia, 2012; Kurtz *et al.*, 2021). As an example, in Asian advertisements, traditional buildings are used to illustrate cultural differences. Non-Asian participants viewed this aspect as an attractive feature as they are unfamiliar with the locations and seeing a different

Source(s): Jayawardena (2022)

Figure 11.
NVivo QSR word cloud analysis–360-degree video version (male participants)

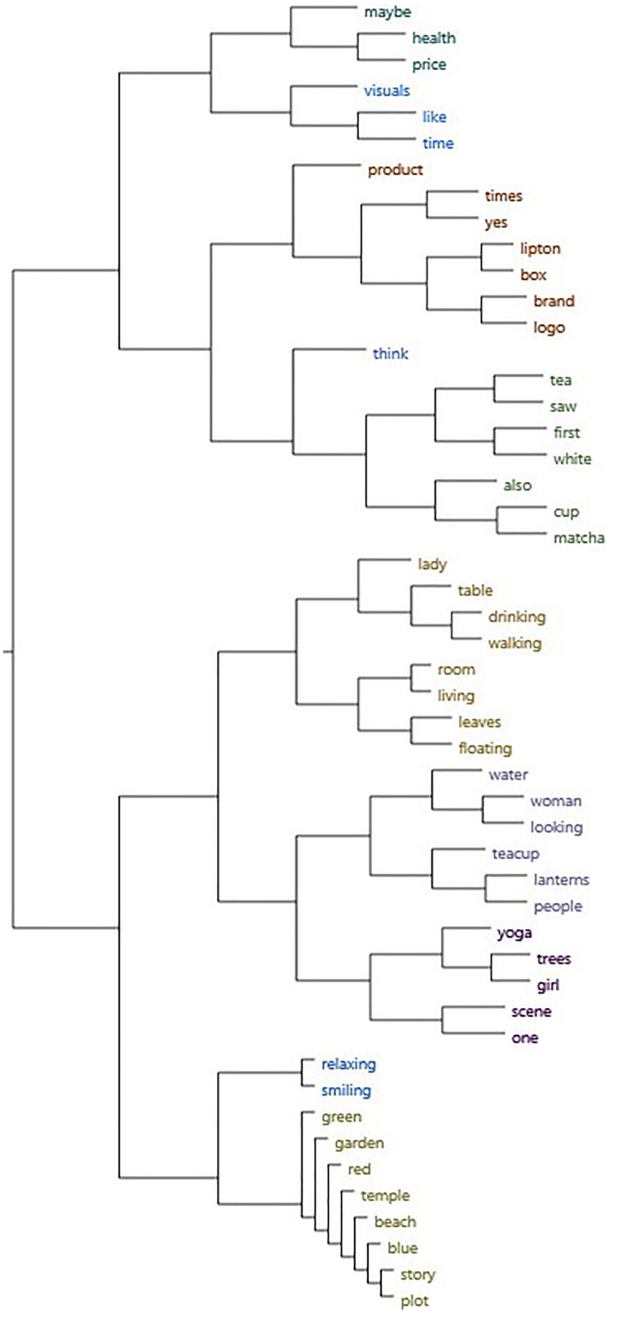
environment makes them curious (Morris, 2014). Consequently, advertising designers have used different locations to advertise products by taking advantage of the curiosity amongst consumers as a competitive advantage (Banerjee and Roy Dholakia, 2012). Findings revealed that both female and male participants observed several locations in both viewing conditions with no gender difference being observed. These findings are consistent with previous findings of Banerjee and Roy Dholakia (2012) and Kurtz *et al.* (2021).

5.4 Storytelling or plot of the advertisement

Storytelling is also known as narrative advertising (Tenic, 2018; Feng *et al.*, 2019). The theme regarding the plot was identified as a result of the second experiment in which consumers were able to understand the tea leaf journey of this advertisement better after viewing it for the second time. Therefore, as a major visual comprehension strategy, it was identified that when arranging visuals for advertisements, it is necessary to arrange the visuals according to the order of the story (Tenic, 2018; Feng *et al.*, 2019; Zhu *et al.*, 2018). For example, the first scene can be about the product, the second scene can be about the benefits of the product, while the third scene can be about the product information such as brand logo, price and quality (Cohen and Dromi, 2018). These findings are in line with previous works by Cohen and Dromi (2018), Feng (2018) and Feng *et al.* (2019).

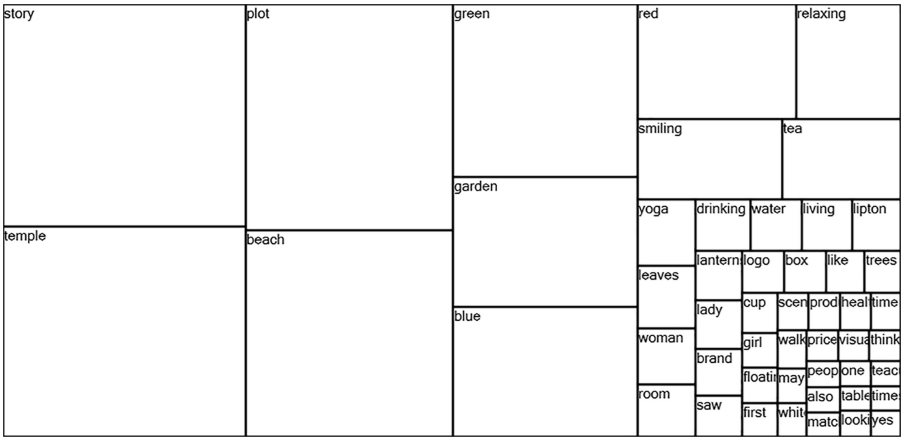
6. Theoretical and managerial implications

The application of a social psychology theory for the advertising sector enables the gathering of more insights about the social cognition stages of the human mindset, such as information retrieval, judgement, decision making, goal stimulation and short- and long-term memory (Van Lange *et al.*, 2012). In doing so, this study not only explores visual comprehension memory for 360-degree video advertisements amongst adolescents but also contributes to the theory of social information processing by Wyer (2003) by being amongst the first comparative studies where previously no benchmark or comparison data have been available (Krishna *et al.*, 2016; Feng *et al.*, 2019). This can be further justified based on the most recent empirical comparison study of 360-degree video advertisements versus standard video advertisements using a narrative structure (Feng *et al.*, 2019). The results indicated that the superiority of 360-degree video advertising over standard video advertising is maximised when its standard version exhibits a moderate narrative structure and is attenuated when either a low or a high narrative structure is included. Findings indicated the availability of no



Source(s): Jayawardena (2022)

Figure 12.
Node cluster diagram using word similarity approach



Source(s): Jayawardena (2022)

Figure 13.
Treemap analysis

Themes	Concepts derived from node cluster diagram	Concepts derived from tree map analysis
Colour detection	Visuals, white, green, red, blue	Green, blue, red, white
The visual memory of locations	Garden, temple, beach, living, room	Temple, beach, garden
The plot or storytelling	Story, plot, scene	Story, plot

Table 12.
Thematic classification based on the treemap analysis and node cluster diagram

Theme	Codes	NVivo QSR query results
Visual content with locations	Room	Beginning I saw that I was inside the tea itself then it transited to different scenes of the nature garden the lanterns and the living room (P11)
	Beach	* A girl doing yoga on the beach represents the purpose of why people drink . . . (P7)
	Garden	* Beginning water leaves and garden with a bridge and a lake (P18)
	Living	* They drink tea so they can relax in the living room, ... (P10)
	Temple	*Someone in the temple. . . (P16)
Colour detection	Green	*In the first visual some are not noticeable. The same advertisement. Is this the same one? The matcha box was not there in the first one. I did not look around and down. I saw the LIPTON logo and the empty cup and some green water (P4)
	Maroon	*She was wearing a maroon colour top with black colour pants (P14)
Storytelling techniques	Leaves	*Green leaves floating . . . (P9)
	Story	* . . . so, this is about the tea-making process of the tea leaf . . . . . (P3)

Table 13.
NVivo query findings amongst female participants

benchmark or comparison data focussing on visual comprehension memory with qualitative exploratory research (Feng *et al.*, 2019).

Several practical implications have been suggested when arranging visuals for 360-degree video advertisements. Firstly, to promote products for women, enhancing colour detection in visuals by demonstrating product details is important. Further, when advertising products, the use of the 360-degree view can improve eye movements by adding actions within the visuals

Source(s): Jayawardena (2022)

Figure 14.
NVivo QSR word cloud analysis–360-degree video version (female participants)

(Tang *et al.*, 2017). To promote products for men, it is highly recommended to add some facial expressions to gain the attention of the audience (Mueser *et al.*, 1984; Small and Verrochi, 2009). The usage of different locations to advertise products arouses curiosity amongst consumers (Banerjee and Roy Dholakia, 2012; Kurtz *et al.*, 2021). However, a comparatively small number of locations were noticed in the 360-degree videos due to movement issues (Tenic, 2018). It is also recommended for advertisement designers to arrange the visuals considering the order of the story (Tenic, 2018; Feng, 2018; Feng *et al.*, 2019) and to use interaction techniques such as rich imagery and spatial sound design systems (Tenic, 2018; Zhu *et al.*, 2018) which will help to comprehend the visuals within the advertisements.

7. Conclusion

This study investigated visual comprehension in memory for 360-degree video advertisements amongst adolescents using the theory of social information processing by Wyer (2003). The two main contributions from this study are as follows: from a theoretical perspective, the application of a social psychology theory for the advertising sector enables us to gather more insights about the social cognition stages of a human mindset such as information retrieval, comprehension, judgement, decision making, goal stimulation and short- and long-term memory. In doing so, this study not only explores visual comprehension in memory for 360-degree video advertisements but also contributes to the theory of social information processing by Wyer (2003) by being the first study to investigate visual comprehension in memory for 360-degree video advertisements. From a practical perspective, the findings of this study provide a solid foundation for future advertising firms or agencies, marketers and salespeople on how to design effective advertisements using 360-degree video versions in a way that appeals to consumers' visual comprehension memory.

References

Banerjee, S.S. and Roy Dholakia, R. (2012), "Location-based mobile advertisements and gender targeting", *Journal of Research in Interactive Marketing*, Vol. 6 No. 3, pp. 198-214, doi: 10.1108/17505931211274679.

Cohen, A.C. and Dromi, S.M. (2018), "Advertising morality: maintaining moral worth in a stigmatized profession", *Theory and Society*, Vol. 47 No. 2, pp. 175-206, available at: https://scholar.harvard.edu/shai-dromi/publications/advertising-morality

Cox, D. and Cox, A.D. (2002), "Beyond first impressions: the effects of repeated exposure on consumer liking of visually complex and simple product designs", *Journal of the Academy of Marketing Science*, Vol. 30 No. 2, pp. 119-130, doi: 10.1177/03079459994371.

Di Gregorio, S. (2000), "Using NVivo for your literature review", *Strategies in Qualitative Research: Issues and Results from Analysis Using QSR NVivo and NUD* IST Conference at the institute of Education*, London, pp. 29-30.

Dollah, S., Abduh, A. and Rosmaladewi, M. (2017), "Benefits and drawbacks of NVivo QSR application", *2nd International Conference on Education, Science, and Technology*, Indonesia, Atlantis Press, pp. 61-63, doi: 10.2991/icest-17.2017.2.

Feng, Y. (2018), "Facilitator or inhibitor? The use of 360-degree videos for immersive brand storytelling", *Journal of Interactive Advertising*, Vol. 18 No. 1, pp. 28-42.

Feng, Y. and Mueller, B. (2019), "The state of augmented reality advertising around the globe: a multi-cultural content analysis", *Journal of Promotion Management*, Vol. 25 No. 4, pp. 453-475, doi: 10.1080/10496491.2018.1448323.

Feng, Y., Xie, Q. and Lou, C. (2019), "The key to 360-degree video advertising: an examination of the degree of narrative structure", *Journal of Advertising*, Vol. 48 No. 2, pp. 137-152, doi: 10.1080/00913367.2019.1585305.

Forer, L. (2018), "360 degrees of success: 360 videos vs. regular video [infographic]", Marketing Profs, February, 23.

Geise, S. and Baden, C. (2015), "Putting the image back into the frame: modelling the linkage between visual communication and frame-processing theory", *Communication Theory*, Vol. 25 No. 1, pp. 46-69, doi: 10.1111/comt.12048.

Gray, J.H. and Densten, I.L. (1998), "Integrating quantitative and qualitative analysis using latent and manifest variables", *Quality and Quantity*, Vol. 32 No. 4, pp. 419-431, doi: 10.1023/A:1004357719066.

Habig, J. (2016), "Is 360 video worth it. Think with Google", available at: https://www.thinkwithgoogle.com/intl/en-154/marketing-strategies/video/is-360-video-worth-it (accessed 8 November 2020).

Hartmann, P., Apaolaza, V. and Alija, P. (2013), "Nature imagery in advertising: attention restoration and memory effects", *International Journal of Advertising*, Vol. 32 No. 2, pp. 183-210, doi: 10.2501/IJA-32-2-183-210.

Helm, C. (2020), "Opening up the potential of 360° video for advertising", available at: https://www.huffpost.com/entry/opening-up-the-potential-of-360-video-for-advertising (accessed 8 November 2020).

Higgins, J.W. and Lauzon, L. (2003), "Finding the funds in fun runs: exploring physical activity events as fundraising tools in the non-profit sector", *International Journal of Non-profit and Voluntary Sector Marketing*, Vol. 8 No. 4, pp. 363-377, doi: 10.1002/nvsm.226.

Huettl, V. and Gierl, H. (2012), "Visual art in advertising: the effects of utilitarian vs. hedonic product positioning and price information", *Marketing Letters*, Vol. 23 No. 3, pp. 893-904, doi: 10.1007/s11002-012-9196-z.

Hutchison, A.J., Johnston, L.H. and Breckon, J.D. (2010), "Using QSR-NVivo to facilitate the development of a grounded theory project: an account of a worked example", *International Journal of Social Research Methodology*, Vol. 13 No. 4, pp. 283-302, doi: 10.1080/13645570902996301.

Jayawardena, N.S. (2022), "Investigating consumer visual memory of 360-degree and standard video advertisements: a social information-processing theory perspective", Griffith University, doi: 10.13140/RG.2.2.14264.42247.

Köhler, S., Crane, J. and Milner, B. (2002), "Differential contributions of the parahippocampal place area and the anterior hippocampus to human memory for scenes", *Hippocampus*, Vol. 12 No. 6, pp. 718-723, doi: 10.1002/hipo.10077.

Krishna, A., Cian, L. and Sokolova, T. (2016), "The power of sensory marketing in advertising", *Current Opinion in Psychology*, Vol. 10, pp. 142-147.

Kuisma, J., Simola, J., Uusitalo, L. and Öörni, A. (2010), "The effects of animation and format on the perception and memory of online advertising", *Journal of Interactive Marketing*, Vol. 24 No. 4, pp. 269-282, doi: 10.1016/j.intmar.2010.07.002.

Kurtz, O.T., Wirtz, B.W. and Langer, P.F. (2021), "An empirical analysis of location-based mobile advertising—determinants, success factors, and moderating effects", *Journal of Interactive Marketing*, Vol. 54, pp. 69-85, doi: 10.1016/j.intmar.2020.08.001.

Mazzoni, G., Vannucci, M. and Batool, I. (2014), "Manipulating cues in involuntary autobiographical memory: verbal cues are more effective than pictorial cues", *Memory and Cognition*, Vol. 42 No. 7, pp. 1076-1085, doi: 10.3758/s13421-014-0420-3.

McNeal, J.U. and Ji, M.F. (2003), "Children's visual memory of packaging", *Journal of Consumer Marketing*, Vol. 20 No. 5, pp. 400-427, doi: 10.1108/07363760310489652.

Morris, P.K. (2014), "Comparing portrayals of beauty in outdoor advertisements across six cultures: Bulgaria, Hong Kong, Japan, Poland, South Korea, and Turkey", *Asian Journal of Communication*, Vol. 24 No. 3, pp. 242-261, doi: 10.1080/01292986.2014.885535.

Morse, J.M. (2000), "Determining sample size", *Qualitative Health Research*, Vol. 10 No. 1, pp. 3-5, doi: 10.1177/104973200129118183.

Mueser, K.T., Grau, B.W., Sussman, S. and Rosen, A.J. (1984), "You're only as pretty as you feel: facial expression as a determinant of physical attractiveness", *Journal of Personality and Social Psychology*, Vol. 46 No. 2, pp. 469-478, doi: 10.1037/0022-3514.46.2.469.

O'Neill, M. (2013), "The NVivo Toolkit: how to apply NVivo in your PhD for research and publishing success", *University of the Sunshine Coast*, available at: https://acuresearchbank.acu.edu.au/item/891wy/the-nvivo-toolkit-how-to-apply-nvivo-in-your-phd-for-research-and-publishing-success (accessed 8 November 2020).

Pechmann, C. and Stewart, D.W. (1988), "Advertising repetition: a critical review of wearin and wearout", *Current Issues and Research in Advertising*, Vol. 11 Nos 1-2, pp. 285-329, doi: 10.1007/BF02173410.

Pieters, R., Wedel, M. and Batra, R. (2010), "The stopping power of advertising: measures and effects of visual complexity", *Journal of Marketing*, Vol. 74 No. 5, pp. 48-60.

Preston, S.D. and De Waal, F.B. (2002), "Empathy: its ultimate and proximate bases", *Behavioral and Brain Sciences*, Vol. 25 No. 1, pp. 1-20, doi: 10.1017/s0140525x02000018.

Rossiter, J.R., Silberstein, R.B., Harris, P.G. and Nield, G. (2001), "Brain-imaging detection of visual scene encoding in long-term memory for TV commercials", *Journal of Advertising Research*, Vol. 41 No. 2, pp. 13-21, doi: 10.2501/JAR-41-2-13-21.

Sell, M.A., Ray, G.E. and Lovelace, L. (1995), "Preschool children's comprehension of a Sesame Street video tape: the effects of repeated viewing and previewing instructions", *Educational Technology Research and Development*, Vol. 43 No. 3, pp. 49-60, doi: 10.1007/BF02300455.

Shaouf, A., Lü, K. and Li, X. (2016), "The effect of web advertising visual design on online purchase intention: an examination across gender", *Computers in Human Behaviour*, Vol. 60, pp. 622-634, doi: 10.1016/j.chb.2016.02.090.

Shen, J., Wang, Y., Chen, C., Nelson, M.R. and Yao, M.Z. (2020), "Using virtual reality to promote the university brand: when do telepresence and system immersion matter?", *Journal of Marketing Communications*, Vol. 26 No. 4, pp. 362-393.

Silverman, R. (2013), "Investigating video as a means to promote vocabulary for at-risk children", *Contemporary Educational Psychology*, Vol. 38 No. 3, pp. 170-179.

Skouteris, H., Kelly, L., Dorning, D.E., Calgaro, K., Corns, B., Feehan, E.L., Hamilton, F., Mahoney, J., Macdonald, Z., Tamburrini, S. and Wood, C. (2007), "Do young children get the message? The effects of repeated video viewing on explicit and implicit information", *Australian Journal of Educational and Developmental Psychology*, Vol. 7, pp. 98-107.

Small, D.A. and Verrochi, N.M. (2009), "The face of need: facial emotion expression on charity advertisements", *Journal of Marketing Research*, Vol. 46 No. 6, pp. 777-787.

Srull, T.K. and Wyer, R.S. (1980), "Category accessibility and social perception: some implications for the study of person memory and interpersonal judgments", *Journal of Personality and Social Psychology*, Vol. 38 No. 6, pp. 1-841.

Srull, T.K. and Wyer, R.S. (1989), "Person memory and judgment", *Psychological Review*, Vol. 96 No. 1, pp. 58-83, doi: 10.1037/0033-295X.96.1.58.

Tang, A., Fakourfar, O., Neustaedter, C. and Bateman, S. (2017), *Collaboration in 360 Videochat: Challenges and Opportunities*, University of Calgary, doi: 10.11575/PRISM/31064.

Tatler, B.W., Gilchrist, I.D. and Land, M.F. (2005), "Visual memory for objects in natural scenes: from fixations to object files", *The Quarterly Journal of Experimental Psychology Section A*, Vol. 58 No. 5, pp. 931-960, doi: 10.1080/02724980443000430.

Tenic, A. (2018), "Guidance in a 360-degree video with the help of special effects: attracting attention to a specific object or segment in a 360-degree video using graphical elements, lights, and colours", Bachelor's thesis, *Linnaeus University*, available at: http://lnu.diva-portal.org/smash/get/diva2:1247362/FULLTEXT01.pdf

Van Lange, P.A., Kruglanski, A.W. and Higgins, E.T. (2012), *Handbook of Theories of Social Psychology*, 1st ed., Vol. 1, SAGE Publications.

Watson, Z. (2017), "Virtual reality for news: the news reality", *Reuters Institute for the Study of Journalism*, Oxford, available at: https://reutersinstitute.politics.ox.ac.uk/our-research/vr-news-new-reality (accessed 8 February 2022).

Wedel, M. and Pieters, R. (2000), "Eye fixations on advertisements and memory for brands: a model and findings", *Marketing Science*, Vol. 19 No. 4, pp. 297-312.

Wedel, M. and Pieters, R. (2008), "Introduction to visual marketing", in Wedel, M. and Pieters, R. (Eds), *Visual Marketing: From Attention to Action*, Taylor & Francis Group/Lawrence Erlbaum Associates, pp. 1-8.

Wu, K., Vassileva, J., Zhao, Y., Noorian, Z., Waldner, W. and Adaji, I. (2016), "Complexity or simplicity? Designing product pictures for advertising in online marketplaces", *Journal of Retailing and Consumer Services*, Vol. 28, pp. 17-27.

Wyer, J. (2003), *Social Comprehension and Judgment: The Role of Situation Models, Narratives, and Implicit Theories*, Psychology Press, New York, pp. 1-440.

Wyer, R.S. and Martin, L.L. (1986), "Person memory: the role of traits, group stereotypes, and specific behaviors in the cognitive representation of persons", *Journal of Personality and Social Psychology*, Vol. 50 No. 4, pp. 661-675.

Xu, M., Li, C., Zhang, S. and Le Callet, P. (2020), "State-of-the-art in 360 video/image processing: perception, assessment and compression", *IEEE Journal of Selected Topics in Signal Processing*, Vol. 14 No. 1, pp. 5-26, doi: 10.1109/JSTSP.2020.2966864.

Zaragoza, M.S. and Mitchell, K.J. (1996), "Repeated exposure to suggestion and the creation of false memories", *Psychological Science*, Vol. 7 No. 5, pp. 294-300, doi: 10.1111/j.1467-9280.1996.tb00377.

Zhou, Y., Zheng, D., Chen, X. and Yu, Y. (2021), "A study on the influence of the facial expressions of models on consumer purchase intention in advertisements for poverty alleviation products", *Personality and Individual Differences*, Vol. 172 No. 1, pp. 1-10, doi: 10.1016/j.paid.2020.110578.

Zhu, Y., Zhai, G. and Min, X. (2018), "The prediction of head and eye movement for 360-degree images", *Signal Processing: Image Communication*, Vol. 69, pp. 15-25.

Further reading

Cisse, M. (2017), "Is 360-degree and VR video the future of marketing?", Retrieved February 8, 2020, available at: https://marketingtechnews.net/news/2017/jul/06/360-degree-and-vr-video-future-marketing

Wyer, R.S. Jr and Kardes, F.R. (2020), "A multistage, multiprocess analysis of consumer judgment: a selective review and conceptual framework", *Journal of Consumer Psychology*, Vol. 30 No. 2, pp. 339-364, doi: 10.1002/jcpy.1158.

Corresponding author
Nirma Sadamali Jayawardena can be contacted at: nirma.jayawardana@griffith.edu.au