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Who Nose What Eye Can See?
Examining the Impact of Scent on Visual Attention

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## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>2</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>5</td>
</tr>
<tr>
<td>Abstract</td>
<td>6</td>
</tr>
<tr>
<td>Introduction</td>
<td>7</td>
</tr>
<tr>
<td>Literature Review</td>
<td>10</td>
</tr>
<tr>
<td><em>The Role of Attention</em></td>
<td>10</td>
</tr>
<tr>
<td><em>Scent in Marketing Communication</em></td>
<td>11</td>
</tr>
<tr>
<td><em>The Congruency of Scent</em></td>
<td>13</td>
</tr>
<tr>
<td><em>Scent Congruency and Visual Attention</em></td>
<td>14</td>
</tr>
<tr>
<td>Conceptual Framework</td>
<td>15</td>
</tr>
<tr>
<td><em>The Impact of Scent on Visual Attention towards Congruent Pictures and Text</em></td>
<td>15</td>
</tr>
<tr>
<td><em>The Impact of Scent on Visual Attention towards Congruent Colors</em></td>
<td>19</td>
</tr>
<tr>
<td><em>The Impact of Scent on Visual Attention towards Semantically Congruent Cues</em></td>
<td>21</td>
</tr>
<tr>
<td>Methodology</td>
<td>26</td>
</tr>
<tr>
<td>Pretest</td>
<td>26</td>
</tr>
<tr>
<td><em>Study One: Scent and Congruency</em></td>
<td>27</td>
</tr>
<tr>
<td>Sample</td>
<td>27</td>
</tr>
<tr>
<td>Design</td>
<td>28</td>
</tr>
<tr>
<td>Stimulus Materials</td>
<td>28</td>
</tr>
<tr>
<td>Experimental Procedure</td>
<td>30</td>
</tr>
<tr>
<td>Measures</td>
<td>31</td>
</tr>
<tr>
<td><em>Study Two: Scent and Color Congruency</em></td>
<td>32</td>
</tr>
<tr>
<td>Sample</td>
<td>32</td>
</tr>
<tr>
<td>Design</td>
<td>32</td>
</tr>
<tr>
<td>Stimulus Materials</td>
<td>33</td>
</tr>
<tr>
<td>Experimental Procedure</td>
<td>33</td>
</tr>
<tr>
<td>Measures</td>
<td>35</td>
</tr>
<tr>
<td><em>Study Three: Scent and Semantic Congruency</em></td>
<td>36</td>
</tr>
<tr>
<td>Sample</td>
<td>36</td>
</tr>
</tbody>
</table>
THE IMPACT OF SCENT ON VISUAL ATTENTION

Design 36
Stimulus Materials 37
Experimental Procedure 38
Measures 38

Data Analysis and Findings 39
Sample Profile 39
Manipulation Check 39
Study One: Scent and Congruency 40
Study Two: Scent and Color Congruency 45
Study Three: Scent and Semantic Congruency 49
Summary of Research Findings 54

Discussion 55
Implications 57
Limitations and Future Research 59

References 61
List of Appendices

Appendix A  Scent Pretest Results: Mean Scores

Appendix B

Figure 1a  Study One: Print Advertisement (Pictorial) – Congruent Cue
Figure 1b  Study One: Print Advertisement (Pictorial) – Incongruent Cue
Figure 2a  Study One: Print Advertisement (Textual) – Congruent Cue
Figure 2b  Study One: Print Advertisement (Textual) – Incongruent Cue
Figure 3a  Study Two: Print Advertisement (Color) – Congruent Cue
Figure 3b  Study Two: Print Advertisement (Color) – Incongruent Cue
Figure 4a  Study Three: Print Advertisement (Pictorial) – Congruent Cue
Figure 4b  Study Three: Print Advertisement (Pictorial) – Incongruent Cue
Figure 5a  Study Three: Print Advertisement (Textual) – Congruent Cue
Figure 5b  Study Three: Print Advertisement (Textual) – Incongruent Cue
Abstract

Extant literature has shown that sensory cues, such as scent, affect how visual and visuo-motor tasks are carried out. While many cross-modal studies have explored the interactions between olfactory and visual cues, little research has examined the effects of scent on visual attention specifically. Our research aimed to determine whether scents can enhance visual attention towards congruent stimuli in the context of an advertisement. 148 participants were recruited for three studies, where their visual attention (i.e. frequency and duration of eye fixation) was recorded using an eye tracking system. In Study One, subjects in the treatment condition were asked to view a series of print advertisements in the presence of a scent. The print ads contained pictorial or textual cues that were either congruent or incongruent to the scent. Results showed that visual attention towards a pictorial or textual cue was significantly greater when it was congruent to the scent accompanying the ad. In Studies Two and Three, color perceptions and semantic associations of scent were explored. Findings revealed that visual attention towards a pictorial or textual cue was also significantly increased when it was either ‘color congruent’ or semantically congruent with the scent. Our collective findings demonstrate an olfactory priming effect on visual selective attention, where a scent can enhance visual attention towards specific cues in an advertisement if they are directly or semantically congruent with the scent. Implications of the findings for advertisers and marketers are discussed.
Introduction

The Problem of Ad Clutter

In recent decades, the vast proliferation of advertisements in the global marketplace has contributed to the growing problem of advertising clutter. According to the Magazine Publishers of America (2010), the average consumer magazine now contains 48 percent advertising and 52 percent editorial; other reports indicate that many print publications contain ads on more than half of their pages (Belch & Belch, 2007; Ha & Lithas, 1997). Moreover, with the Internet allowing advertisements to be manifested in various formats, ranging from pop-ups to paid text links and banner ads, the problem of clutter becomes all the more salient.

As a result of this phenomenon, marketers recognise the need to rise above the clutter of competing advertisements, in order to capture the attention of potential customers. This is as attention enables consumers to select a subset of information and grant it priority for processing (Phelps, Ling & Carrasco, 2006). Wedel and Pieters (2000) argue that in order to achieve this goal, advertisers need to understand how consumers pay attention to advertisements. Building on that, they also need to identify the factors that affect attention, and how to tailor these factors into their marketing strategy.

The Rise of Scent Marketing

Phelps, Ling and Carrasco (2006) revealed that attention to information in one’s environment is more substantial when the information is emotionally arousing. As scent is able to elicit emotional responses in consumers (Herz, 2009), the coupling of scent in marketing may be able to increase the emotional saliency of marketing stimuli, thus enhancing consumer attention towards them.
As such, the trend of marketers using scent to promote products or position their brands (Vlahos, 2007) is on the rise (Morrin, 2009). Marketers have used scent as a primary product attribute, such as in personal fragrances and room deodorizers or as a secondary product attribute in scent-infused products. Scent has also been incorporated into advertising and sales promotion efforts (e.g. scent slip or scratch-and-sniff patches), and used as ambient scents in hotels, retail stores, casinos and restaurants (Morrin, 2009). More recently, new avenues of scent marketing have also been explored. For example, scent diffusers were installed in cinema halls in Golden Village Singapore, to release a chocolate scent during movie screenings of ‘Charlie and the Chocolate Factory’ (Hong, 2006).

Research Objectives

To date, however, few studies have been done to examine the effect of scent in directing visual attention towards specific cues within advertisements. Most extant literature on olfactory-visual research focused on how visual stimuli can affect olfactory performance. However, little is known about the reverse (Seo et al., 2010). Moreover, past studies on scent and attention have mostly evaluated attention in terms of the amount of time consumers take to evaluate stimuli encountered (Morrin & Ratneshwar, 2000), rather than to examine the specific cues consumers pay attention to. As such, the objective of our research is to explore whether scent has the ability to direct consumers’ visual attention towards specific cues in an advertisement.

Moreover, Seo et al.’s (2010) study revealed that the impact of scent in directing visual attention towards a stimulus can be enhanced if the stimulus is directly congruent to the scent (e.g. lemon scent with lemon visual stimulus). Our other objective, therefore, is to find out whether that scent-congruency effect can be extended beyond directly congruent
stimuli to secondary ‘levels’ of congruency (e.g. the semantic ‘meanings’ of scent or perceived ‘colors’ of scent).

Our research will consist of three studies. Study One will explore the effects of scent and congruency on visual attention towards advertisements. Study Two will investigate the impact of scent and color congruency on visual attention. Lastly, Study Three will examine the effects of scent and semantic congruency on visual attention towards advertisements. An eye tracker will be used to conduct these studies.

This paper will be organized as follows. First, a literature review of past studies on visual attention, scent in marketing, and the effects of scent-stimuli congruency will be presented. Next, our hypotheses will be developed within the conceptual framework. This will be followed by details of our methodology, and the results of our three studies. The paper will then conclude with a discussion of our findings and their implications, as well as the limitations faced and suggestions for future research.
Literature Review

The Role of Attention

Psychologists define attention as the aspect of human cognition that reacts to the constraints in mental resources and capacity when processing information (Shiffrin, 1988). Desimone and Duncan (1995) elaborated that humans possess limited capacity for processing information, as only a small amount of information available to the retina can be processed and used at any one time. As such, there is the need for humans to practice selective visual attention, in order to cope with the cognitive limitations in information processing.

Motivators of Visual Attention. Visual attention can be goal-driven (‘top-down’ control) or stimulus-driven (‘bottom-up control’). Attention is said to be goal driven when it is controlled by the observer’s deliberate strategies and intentions. For example, visual attention is goal-driven when one is looking for a certain type of cereal in a yellow box at the supermarket, and thus starts to pay attention to yellow boxes in general. On the other hand, attention is said to be stimulus-driven when it is controlled by a salient attribute of an image that is not necessarily relevant to the observer’s perceptual goals. For example, a single red cereal box in a sea of yellow is more visually salient than its surroundings, and thus can lead to stimulus-driven visual attention (Yantis, 1988).

Visual Attention and Information Processing. Attention plays many roles and brings about many benefits in the course of information processing. Firstly, attention can act as an amplifier, making the processing of information in an attended region more efficient. Moreover, attention can also affect stimulus perception by enhancing stimulus processing or by filtering away distracting information. In addition, attention can also have an effect on memory and recall. This is as paying attention to certain aspects of a scene can cause one to remember information more effectively (Johnson & Proctor, 2004).
**Visual Attention and Eye Movement.** Visual attention and eye movement are closely related as our covert attention system plays an important role in guiding our overt eye movements. This means that eye movements directed to a location in space are preceded by a shift in visual attention to the same location (Hoffman, 1998). Thus, as eye movement is an eminent indicator of the covert visual attention process, the examination of eye movements using an eye tracker is becoming increasingly common in the study of visual attention.

In the last decade, there has been a rapid growth in commercial applications of eye-tracking technology in the United States, Europe, Asia and Australia, to assess the effectiveness of visual-marketing efforts. Similarly, in the academic research field, there has been a surge of interest in eye tracking studies in the 1990s and 2000s (Wedel & Pieters, 2008). Examples of such studies include Rayner et al.’s (2001) study on how a one’s cognitive goal can determine visual attention.

**Scent in Marketing Communication**

**Neurological Processes of Scent.** The human olfactory system consists of at least 1000 types of olfactory receptors located in the sinus cavity (Ciccarelli & Meyer, 2006). Distinct odorants bind to varied combinations of receptors such that humans can recognise more than 10,000 different odors (Travis, 1999). Scent information is relayed from the olfactory bulbs directly to the limbic system, which is a set of brain structures highly linked to memory and emotions (Ellen & Bone, 1998). The limbic system comprises both the amygdala, a vital structure for the processing and memory of emotional reactions, and the hippocampus, which is essential for long-term memory (Ciccarelli & Meyer, 2006). As such, this suggests that the presence of an odor can both trigger emotions and help retrieve stored memories (Herz & Cupchik, 1995).
**Effects of Scent in Marketing Communications.** Scent has been noted to have an effect on consumers’ memories (Herz, 1998; Herz, 2000; Aggleton & Waskett, 1999; Morrin & Ratneshwar, 2003) and emotions (Warenburg, 2005; Ehrlichman & Bastone, 1992). Herz (1998) for example, discovered through a series of cross-modal experiments, that odors were on par with other stimuli (verbal, visual, tactile and musical stimuli) in their ability to elicit accurate recall, but that odor-evoked memories rated higher in emotionality. As such, Herz (1998) concluded that the emotional saliency of odors is a possible reason why scent is a superior memory cue. Morrin and Ratneshwar (2003) confirm this as their study revealed that ambient scent can improve recall and recognition of both familiar and unfamiliar brands.

In addition, Warrenburg (2005) also studied the effect of scent on emotions, by developing a self-report method to reliably measure the mood associations of odors. With it, he measured if relaxing scents were able to reduce laboratory-induced stress responses, and hence be used as a stress-relief agent in consumer products. Warrenburg (2005) discovered that scent was not only powerful enough to counteract stress in a performance task (i.e. alter moods), but could also elicit physiological responses such as the reduction of stress-induced muscle tension in the shoulder area.

Besides affecting consumers psychologically and physiologically, scent has also been discovered to have an impact on consumer behaviour as well. Studies have shown that a scented environment can lead to consumers staying longer in stores, or spending more money. Shoppers underestimate the amount of time they spend shopping by 26%, when they are exposed to pleasant aromas such as clementine and vanilla (Burling, 2006, p. D1). Also, a study by Hirsch (1995) revealed that the presence of a pleasant ambient scent in a casino can affect slot machine gambling behaviour, as areas scented with the ambient scent reported increases in slot revenues produced (i.e. increase in spending).
Moreover, scent can also have an effect on consumer evaluations of products and shopping environment. Spangenburg et al. (1996) for example, noted that the presence of a scent can have a positive effect on a consumer’s assessment of a store environment and on the products sold.

**The Congruency of Scent**

Moreover, ‘perceived congruency’ as a cognitive moderator, has been reviewed frequently in olfactory research, and has been proven to play a significant role in determining the impact of scent on consumer perceptions and attitudes (Elder et al., 2009). ‘Perceived congruency’ has generally been defined and conceptualized as a contextual fit between a scent and a product or product category (Bosmans, 2006; Morrin & Ratneshwar, 2003). However, past research has also operationalized it in many other ways, including congruency with the arousal level of ambient music in a store (Matilla & Wirtz, 2001), as well as congruency with the gender of the shopper (Spangenberg et al., 2006).

The existence of congruence between an olfactory stimuli and the product advertised has been reported to have a more positive influence on recall (Elder et al., 2009), product evaluation (Bosmans, 2006), shopping experience (Matilla & Wirtz, 2001) and buying behaviour (Matilla & Wirtz, 2001; Spangenberg, Sprott, Grohmann & Tracy, 2006), as compared to if there were incongruence. Mattila & Wirtz’s (2001) study for example, reported positive interaction effects on approach behavior, pleasure, and satisfaction when the type of scent (low or high arousal) and music (low or high arousal) were congruent with each other. Such a result may be attributed to the fact that humans generally tend to react positively to congruency and negatively when expectations of congruency are violated (Mandler, 1982).
**Congruency and Purchase Intention.** Extant research has shown that scent can elicit increased pleasure and arousal in consumers, which in turn can predict customer behaviour in retail settings (Donovan and Rossiter, 1982). The pleasure-displeasure dimension reflects the degree, to which a person feels happy, joyful, good or satisfied with the situation, whereas the arousal-non arousal dimension taps the degree to which a person feels alert, excited, stimulated or active in the situation. Sherman et al. (1997) support this phenomenon with their study, which revealed that pleasure and arousal had a positive impact on money spent.

However, the arousal and pleasure experienced by consumers can be enhanced when they experience congruent stimuli in their shopping experience. Mattila and Wirtz’s (2001) study for example, investigated the effects of scent-music congruency on consumer behaviour, and found that consumers felt increased levels of pleasure, and exhibited higher levels of approach and impulse buying behaviour, when scent and music were congruent. As such, the coupling of scent with another congruent stimulus in marketing may be able to increase the purchase intention of consumers.

**Scent Congruency and Visual Attention**

Likewise, the use of scent may be able to direct attention towards a stimulus congruent to the scent. Seo et al.’s (2010) study investigated whether odors can enhance attention towards visually presented objects congruent with the odors, by assessing the total number and time of eye fixations using an eye tracking system. They presented participants with photographic slides containing one congruent and three incongruent objects with the respective odors, and discovered that in the presence of an odor, participants looked more frequently and longer at a corresponding object as compared to the odorless condition.
Conceptual Framework

The Impact of Scent on Visual Attention towards Directly Congruent Pictures and Text

The Taxonomy of Eye Movements. According to Duchowski (2007), saccades are rapid eye movements used in repositioning the fovea to a new location in the visual environment, while fixations are eye movements that stabilize the retina over a stationary object of interest. As such, fixations and saccades provide evidence of voluntary, overt visual attention. It was suggested that fixations naturally correspond to the desire to maintain one’s gaze on an object of interest, while saccades are considered manifestations of the desire to voluntarily change the focus of attention (Duchowski, 2007).

Eye Movement and Cognitive Processing. Eye movements have long been used to infer cognitive processes. Early studies on visual attention have showed that eye movement patterns during complex scene perception are related to the information in the scene, and by extension, to perceptual and cognitive processing of the scene. Henderson and Hollingworth (1998) revealed that when one perceives a scene, the positions of the fixations are nonrandom, with fixations clustering on informative regions. Several metrics can be used to evaluate the relative ‘informativeness’ of these regions, such as the total time a region is fixated upon in the course of scene viewing (i.e. fixation length). This measure is also correlated with the number of fixations in that region (i.e. frequency). It was moreover revealed that semantically informative objects tend to draw longer total fixation durations (Duchowski, 2007).

Several studies have indicated that visual attention (i.e. fixation on informative regions) is dependent on the cognitive goal of the viewer (Pieters & Wedel, 2007; Rayner et al. 2001; Rayner et al. 2008; Yarbus, 1967). An experiment by Rayner et al. (2001) revealed that when participants were asked to consider purchasing a car or skin care products off print advertisements, they looked earlier and more frequently at the text rather than the picture part.
of the advertisements, to obtain more information related to the products. In contrast, the opposite results (i.e. greater fixation on picture than text) were obtained when participants were asked to rate pleasantness or effectiveness of the presented advertisements (Rayner et al., 2008).

Furthermore, Pieters & Wedel (2007) found out that an ad-memorization goal enhanced attention to the advertisement’s body text, pictures and brand, while a brand-learning goal enhanced attention to the body text but simultaneously inhibited attention to the pictorial.

As a result, these studies appear to reinforce the idea that the relative ‘informativeness’ of objects in a scene is dependent on the specific cognitive processing goal that is activated, and that eye movements are determined by and thus reflect the extent to which these objects are informative.

**Cross-Modal Interactions between Scent and Vision.** A substantial amount of past research has examined cross-modal interactions between visual and olfactory stimuli (Castiello et al., 2006; Dematte et al., 2007; Knasko, 1995; Michael et al., 2003; Millot et al., 2002; Tubaldi, Ansuin et al., 2008; Tubaldi, Ansuini, Tirindelli, et al., 2008). In Dematte, Osterbauer and Spence’s study (2007), olfactory cues were found to have an influence on people's judgments of facial attractiveness. The results showed that male faces were rated significantly less attractive in the presence of an unpleasant odour, than when the faces were unscented or accompanied with a pleasant scent.

Scent has also been found to have an impact on visuo-motor skills. In another study by Tubaldi, Ansuini, Tirindelli and Castiello (2008), kinematics was used to explore the interaction between vision and olfaction during grasping movements. Participants were asked to smell an odorant and then grasp a target object presented in central vision. The results
showed that the odour affected how participants grasped the targets. When the odour evoked a larger object (e.g. an orange), the amplitude of maximum hand aperture was greater even when the target was small (e.g. a strawberry). Conversely, the amplitude of maximum hand aperture was reduced when the target was large (e.g. a peach), but the odour evoked a smaller sized object (e.g. an almond).

_Scent, Cognitive Processing and Visual Attention_. While extant literature has demonstrated the influences of olfactory cues on visual and visuo-motor tasks, most studies on olfactory-visual integration still assume visual cues to dominantly modulate olfactory performance (Thesen, Vibell, Calvert, & Osterbauer, 2004). As such, there have been few studies expounding on how olfactory cues can in turn influence visual behaviour and more specifically, visual attention.

However, research on the evolutionary behaviours of animals show that olfactory cues do dominantly influence visual cues in animals, when it comes to food foraging and spatial navigation. (Chow & Frye, 2008; Duistermars & Frye, 2008; Frey, Tarsitano, & Dickinson, 2003; Maaswinkel & Li, 2003). Zebra fishes for example, experience an increase in visual sensitivity, when amino acids (olfactory stimuli) were added into the aquarium (Maaswinkel & Li, 2003). Moreover, Reinhard et al.’s (2004) study on honey bees also shed light on how a previously experienced scent can stimulate specific visual cues and memories in animals. Furthermore, an early study by Knasko (1995) attempted to explore the effects of pleasant scents on attention to photographs. Through the study, he found that subjects viewed corresponding photographs longer (i.e. longer viewing duration), in the presence of a pleasant scent.

More recently, a study by Seo et al. (2010) sheds further light on the topic, by revealing that odors can enhance attention towards visually presented objects that are
congruent with the odors. In the study, the researchers suggested that a possible explanation as to why odors may augment visual attention towards corresponding objects, is because individuals are constantly identifying objects in their external world, and this may drive them to connect the olfactory stimuli with external objects, in order to label and identify the odors (i.e. What is this odor?). As such, the presence of an odor may encourage one to look at a congruent object more often, in order to aid in the correct identification of the odor source.

Therefore, in light of previous research on how the goal of a viewer can affect his visual attention (Pieters & Wedel, 2007; Rayner et al. 2001; Rayner et al. 2008; Yarbus, 1967) towards ‘informative’ regions (Henderson & Hollingworth, 1999), we can conclude that an olfactory stimulus may activate a viewer’s cognitive goal to identify the scent, which results in eye movements being clustered in the informative regions (i.e. congruent objects) of a corresponding scene, so as to help the viewer accomplish his odor identification goal.

In light of this, we aim to expand on Seo et al.’s (2010) study, by examining the effect of odor cues on visual attention towards congruent objects in the context of advertisements. As such, we propose the following hypotheses:

**H1a:** *In the presence of a scent, the subject will spend a longer time fixating on a congruent pictorial cue as compared to an incongruent pictorial cue.*

**H1b:** *In the presence of a scent, the subject will fixate more frequently on a congruent pictorial cue as compared to an incongruent pictorial cue.*

Also, it is interesting to note that Seo et al. (2010) used only pictures in his study. However, as most advertisements contain both visual and verbal elements, we aim to investigate if his findings still apply in the presence of the verbal elements in an advertisement.
Moreover, consumers engage in different modes of information processing when exposed to an advertisement. MacInnis and Price (1987) suggest two possible modes with which consumers process advertisements – the imagery and analytical information processing modes. While the imagery processing mode is based on nonverbal representations of perceptual information (e.g. pictorial cues), the analytical processing mode is data driven and focused on verbal retrieval and encoding (MacInnis & Price, 1987). Hence, we want to take into account the different possible processing modes a consumer can engage in when viewing advertisements, and examine if scent has an effect on visual attention towards congruent verbal stimuli as well. As such, we also propose the following hypotheses:

**H2a:** In the presence of a scent, the subject will spend a longer time fixating on a congruent textual cue as compared to an incongruent textual cue.

**H2b:** In the presence of a scent, the subject will fixate more frequently on a congruent textual cue as compared to an incongruent textual cue.

**The Impact of Scent on Visual Attention towards Congruent Colors**

**Visual Attention and Colour**. Colours are a fundamental part of our lives, and it is an important element in determining the visual conspicuity of an object. Visual conspicuity is the combination of an object’s properties (i.e. shape, size, colour etc.) relative to its background, and it is a factor which influences the selection process executed by the peripheral visual sub-system, in determining where a person’s points of attentional fixation will be (Pearson & Van Schaik, 2003).

As such, the human eye is naturally attracted to coloured objects as compared to those that are in black and white, as they are more visually conspicuous. This is evidently so in the
advertising world, where consumers are more likely to notice colour advertisements before any other type of advertisements (Duchowski, 2007).

**The Colour of Scent.** Previous literature suggests several correlations between scent and colour. The effect of colour on odour identification has been illustrated in studies which show that colour cues can bias odour judgement (Engen, 1972; Zellner & Kautz, 1990), wherein the increased congruency of a colour to a smell can augment the accuracy of odour identification. For example, Zellner, Bartoli and Eckard’s (1991) study revealed that people make fewer errors in identifying the scent of unknown solutions that are colour congruent (e.g. red-cherry), as compared to those that are colour incongruent (e.g. red-lemon).

Past studies also suggest that odours can evoke characteristic colour hues (Gilbert, Martin & Kemp, 1996), as it has been reported that humans do cognitively attach certain fixed colours to respective scents. Gilbert, Martin and Kemp (1996), for instance, reported that people make non-random colour matches to odours, and that these colour matches remain stable over time. Dematte, Sanabria and Spence’s (2007) extension of this study also reported similar findings that suggest odour-colour associations to be both systematic and robust. Such a phenomenon is explained by Melara (1989), who suggests that color-odor consensus is mediated by semantic involvement, whereby smell activates a semantic label which in turn activates a related colour concept in our minds.

Therefore, as we have previously established through past literature that it is plausible for scent to impact one’s visual attention towards a congruent pictorial or textual stimulus, we aim to find out in light of the above literature, if scent may also have the same effect on a semantically congruent colour. As such, we propose the following hypotheses:

*H3a: In the presence of a scent, the subject will spend a longer time fixating on a cue of a congruent color as compared to a cue of an incongruent color.*
**H3b:** *In the presence of a scent, the subject will fixate more frequently on a cue of a congruent color as compared to a cue of an incongruent color.*

In addition, colors have the ability to affect people’s feelings and increase the level of arousal felt (Gorn, Chattopadhyay, Yi & Dahl, 1997), which in turn can lead to greater buying behavior (Sherman et al., 1997). As such, we postulate that this effect may enhance the existing impact of scent-color congruency on arousal and pleasure, leading to increased levels of purchase intention experienced by the consumers. We propose the following hypothesis:

**H3c:** *A scented ad that contains a congruent color cue will elicit a higher likelihood to purchase than an ad that contains an incongruent color cue.*

**The Impact of Scent on Visual Attention towards Semantically Congruent Cues**

**Classical Conditioning Paradigm.** The Classical Conditioning paradigm, developed in 1927 by Ivan Pavlov, is a behavioral learning theory which suggests that specific reactions to certain stimuli can be ‘conditioned’ or ‘learned’ through association. In Pavlov’s experiment, he aimed to illicit salivation in dogs through exposure to two kinds of stimuli. One of the stimulus given was a tone or a light (conditional stimulus), which did not initially offset any salivation reaction in dogs, but subsequently increased in effectiveness due to constant pairing of the stimulus with a food source i.e. associated learning (Domjan & Grau, 2009). Hence in this instance, the dog had learnt to form cognitive associations between the conditional stimulus and ‘food’, which led to the conditional response (i.e. responses that depend on prior training or learning) of salivation.

The Classical Conditioning paradigm has also been applied to research on human behaviour, as can be seen in Sullivan et al.’s (1991) experiment on how new born babies can
be conditioned to respond to a specific odour. In their experiment, they discovered that babies who were first exposed to a citrus scent, followed by tactile stimulation through stroking (as the reinforcing unconditional stimulus) were the only ones who responded to subsequent exposures to the citrus scent, as compared to the other babies in the control groups. The results thus suggest that the babies were capable of complex associative olfactory learning.

**The Learned Meaning of Scents.** Other research has found that it is plausible for cognitive associations to be formed between scents and other sensory cues (Stevenson, Boakes, & Prescott, 1998), or with semantic and episodic knowledge (Degel, Piper, & Koster, 2001; Stevenson & Boakes, 2003), by means of constant co-occurrences (Holland, Hendriks, & Aarts, 2005), as depicted by the Classical Conditioning paradigm. Degel, Piper and Koster’s (2001) study for example, showed that it is possible for implicit odor memories to be subliminally learnt through association with the odor.

Examples of cognitive associations between scent and semantic knowledge include how the scent of pine trees is closely associated with Christmas, or how the scent of citrus may be closely associated with cleanliness. In these cases, when the odor is perceived, the related semantic associations may become activated (Holland, Hendriks, & Aarts, 2005). As such, odors can be said to possess semantically congruent attached meanings, which are in essence developed by ‘learning’ through constant exposure to co-occurrences (E.g. the scent of pine has an attached meaning of ‘Christmas’).

**The Theory of Odor-Associative Learning.** The Theory of Odor-Associative Learning states that once an individual experiences an odor, the context (place, situation, person or event) in which s/he perceives it and its emotional value becomes attached to that aroma (Herz, 2007). It has been proposed that such associative learning principles can explain human perceptual and cognitive–behavioral responses to odors (Engen, 1991; Herz,
2001). In other words, odor-related behavior can result from a learned association between an odor and the emotional context in which that odor was first encountered (Herz, 2005). As such, exposure to an associated odor can influence hedonic perceptions in consumers, and impact their mood and mood-related behaviors. This phenomenon was examined in Herz’s (2005) study, in which children exposed to a particular scent in the failure-frustration manipulation reported lower performance scores in a task when re-exposed to the scent again.

**Scent and Ideo-Motor Behaviours.** Past research has shown that scent can also cognitively influence human behavior, using the same mechanisms that supposedly guide ideomotor action (Holland, Hendriks, & Aarts, 2005). In their study, Holland, Hendriks and Aarts (2005), found out that when participants were exposed to a citrus-scented all purpose cleaner, they were quicker in identifying cleaning related words in a lexical decision task. This could be attributed to the fact that, due to the strong semantic associations between the cleaner scent and the notion of ‘cleaning’, exposure to the scent enhanced the accessibility of the cleaning concept in the participants’ minds, which in turn affected the participants’ responses to cleaning related words in the task. Therefore, this pinpoints the possibility that scent can activate related cognitive associations in people’s minds, which in turn influence behavior.

In particular, previous studies have shown that combinatorial semantics can direct visual attention towards semantically relevant objects in the visual environment (Kamide et al., 2003). In other words, people are more likely to fixate upon an object that is semantically congruent with an image or idea formed in their minds. For example, Cooper (1974) observed that participants were more likely to fixate on a picture showing a sailboat when hearing the semantically related word ‘lake’, which suggests a visual equivalent of semantic priming (Meyer & Schvaneveldt, 1971).
As such, we aim to find out in our study, if exposure to an odor cue can also affect visual attention (behavior) towards pictorial and textual stimuli which depict a strong, semantically-associated meaning to the scent. We propose the following hypotheses:

**H4a:** In the presence of a scent, the subject will spend a longer time fixating on a semantically congruent pictorial cue as compared to a semantically incongruent pictorial cue.

**H4b:** In the presence of a scent, the subject will fixate more frequently on a semantically congruent pictorial cue as compared to an incongruent pictorial cue.

As mentioned in our previous study, we are also interested in examining the effects of scent on semantically congruent textual cues, as advertisements contain both visual and verbal cues, and we want to take into account the different information processing modes used by consumers when processing advertisements. As such, we propose the following hypotheses:

**H5a:** In the presence of a scent, the subject will spend a longer time fixating on a semantically congruent textual cue as compared to a semantically incongruent textual cue.

**H5b:** In the presence of a scent, the subject will fixate more frequently on a semantically congruent textual cue as compared to an incongruent textual cue.

Figure 1a shows a conceptual map giving an overview of our hypotheses and variables.
Figure 1a. Conceptual Map of Scent, Congruency and Attention
Methodology

Our research consisted of three studies. Study One explored the effects of scent and congruency on visual attention towards advertisements (H1a, H1b, H2a and H2b). Study Two investigated the impact of scent and color congruency on visual attention and purchase intention (H3a, H3b and H3c). Study Three examined the effects of scent and semantic congruency on visual attention towards ads (H4a, H4b, H5a and H5b).

The following paragraphs of this chapter are organized into four major sections. The first section gives insights into the pretesting that was carried out prior to conducting the three studies. The second section details the research methodology of Study One, (including sample, design, stimulus materials, experimental procedure and measures). The third and fourth sections describe the methodology of Study Two and Study Three, respectively.

Pretest

Scent. To ensure congruency between our olfactory and visual stimuli, a pretest (n = 14) was conducted among the subject population to find scents that were congruent to the visual cues used in our ads. For Study One, the visual cues were a picture of a lemon (pictorial) and the word ‘Toothpaste’ (textual). In Study Two, a picture of red food coloring was used as the color cue. For Study Three, the cues were a picture of a woman cleaning (pictorial), and the word ‘Clean’ (textual). For each cue, subjects were presented with three variations of a scent. For instance, to test the picture of a lemon, subjects were provided with three variants of lemon scent: Lemon Scent A, Lemon Scent B and Lemon Scent C. Each scent sample was contained in a small, tightly-capped cup containing a strip of filter paper which had been infused with two drops of essential oil. The cups were labeled with letters (‘A’ to ‘C’) and presented in random order. Subjects were then instructed to take at least two sniffs of each sample and evaluate the scent on a five-point scale (1 = not at all, 5 = very much so) on whether or not it corresponded with the cue. The scents with the highest
congruency scores were chosen as the stimuli for the respective cues. See Appendix A for mean scores.

**Identifying Incongruent Cues.** Incongruent cues (for control conditions) were selected from the product categories related to the congruent objects. For instance, if the congruent cue was the word ‘Toothpaste’, the word ‘Shampoo’ was chosen as its incongruent counterpart as it belonged to the same category of products (i.e. toiletries).

**Brand Name.** In selecting brand names to be used in our print advertisements, another pretest ($n = 14$) was conducted among our subject population. This pretest aimed at identifying unfamiliar brand names so as to reduce the likelihood of participants displaying a certain bias during their evaluations of the ads. 40 brands names were selected, 20 of which were familiar (e.g. Pokka, Starbucks, Ikea) and the other 20 were unfamiliar (e.g. Joybee, Rugbys, Fireboy). Familiar brand names were introduced to decrease the chances of random answers and to ensure greater processing effort among participants. Unfamiliar brands were created using an online brand name generator. The 40 brands were listed in random order on a questionnaire and subjects were told to rate the familiarity of each name on a five-point scale (1 = not at all familiar to 5 = very familiar). Eight brands had equally low scores in terms of familiarity ($M = 1.0$) and were shortlisted. Five out of the eight brands were then selected for the print ads based on their suitability to the respective products. See Appendix B for copies of the print advertisements.

**Study One: Scent & Congruency**

**Sample.** 148 university students were recruited for Study One in return for a token gift. Participants were aged 18 to 25, comprising both female and male individuals from varied ethnic backgrounds. Only participants aged 25 and under were recruited as past research has found that younger subjects exhibit eye-tracking measurements that are higher in quality than that of elderly subjects (Spooner, Sakala & Baloh, 1980).
Design. As shown in Figure 1b below, Study One employed a 2 (scent versus no scent) x 2 (congruent versus incongruent) between-subjects factorial design. The four conditions are as follows: an ad with scent and a congruent cue (Condition 1); an ad with scent and an incongruent cue (Condition 2); an ad with the congruent cue used in Condition 1 but with no scent (Condition 3); and an ad with the incongruent cue used in Condition 2 but with no scent (Condition 4).

<table>
<thead>
<tr>
<th>a) 2 x 2: Scent x Congruency (Pictorial Cue)</th>
<th>b) 2 x 2: Scent x Congruency (Textual Cue)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scent</strong></td>
<td><strong>Scent</strong></td>
</tr>
<tr>
<td>Congruent Pictorial Cue</td>
<td>Congruent Textual Cue</td>
</tr>
<tr>
<td>Condition 1</td>
<td>Condition 1</td>
</tr>
<tr>
<td><img src="image1" alt="Condition 1" /></td>
<td><img src="image2" alt="Condition 1" /></td>
</tr>
<tr>
<td>Incongruent Pictorial Cue</td>
<td>Incongruent Textual Cue</td>
</tr>
<tr>
<td>Condition 2</td>
<td>Condition 2</td>
</tr>
<tr>
<td><img src="image3" alt="Condition 2" /></td>
<td><img src="image4" alt="Condition 2" /></td>
</tr>
<tr>
<td><strong>No Scent</strong></td>
<td><strong>No Scent</strong></td>
</tr>
<tr>
<td>Congruent Textual Cue</td>
<td>Congruent Textual Cue</td>
</tr>
<tr>
<td>Condition 3</td>
<td>Condition 3</td>
</tr>
<tr>
<td><img src="image5" alt="Condition 3" /></td>
<td><img src="image6" alt="Condition 3" /></td>
</tr>
<tr>
<td>Incongruent Textual Cue</td>
<td>Incongruent Textual Cue</td>
</tr>
<tr>
<td>Condition 4</td>
<td>Condition 4</td>
</tr>
<tr>
<td><img src="image7" alt="Condition 4" /></td>
<td><img src="image8" alt="Condition 4" /></td>
</tr>
</tbody>
</table>

Figure 1b. Factorial Designs for Study 1: Scent & Congruency

Materials: Olfactory Stimuli. Two pleasant, unique scents (lemon and mint) were used as olfactory stimuli in Study One. For each scent sample, two drops of essential oil were dripped carefully onto a sheet of filter paper measuring approximately 2”x 4”. This process left no permanent marks. Each filter paper was then sealed in a 3”x 4” airtight bag for 48 hours prior to the experiment to further infuse the scent into the filter paper.

Materials: Visual Stimuli. According to Pieters, Warlop and Wedel (2002), print ads typically contain three main elements – the brand, text and pictorial. The brand element in advertisements relates to all pictorial and textual references to the brand, including the name, logo and symbols. The pictorial element includes all illustrations, graphics, and pictures in
the ad, but excludes brand symbols. The textual element consists of all text in the advertisement, such as headlines, sub-headlines and body text, excluding the brand name. To simulate realistic print advertisements, we ensured that each ad designed contained all three elements. In ads that tested congruency to *pictorial* cues, the following were included: a brand element, a heavy pictorial element (e.g. bright, colorful images) and a weak textual element (e.g. brief body copy). In ads that tested congruency to *textual* cues, we incorporated the brand element, a heavy textual element (e.g. longer body copy) and a weak pictorial element (e.g. no image, pictorial element manifested in the arrangement or ‘design’ of text).

With respect to the layout of each print ad, we organized our elements according to Moriarty’s (1991) four main principles of ad functionality: unity, simplicity, contrast and balance. This included using white space to organize and separate elements (unity), using the least possible number of elements (simplicity), as well as noting balance and contrast between the elements.

For Study One, four full-color print advertisements were created, consisting of two main designs (one for pictorial and one for textual). For the pictorial design (Appendix B: Figures 1a and 1b), the ad promoted a fictitious juice bar, and comprised four fruit visuals placed in the four quadrants of the ad. The brand logo was placed at the bottom right hand corner while a brief body copy was positioned at the top of the ad. For Condition 1 (Scent; Congruent) and Condition 3 (No Scent; Congruent), a picture of a lemon was used as the cue, while a picture of a banana was used for Condition 2 (Scent; Incongruent) and Condition 4 (No Scent; Incongruent).

In the textual design (Appendix B: Figures 2a and 2b), the ad promoted a fictitious brand of personal care products, and included four separate words relating to bathroom items. Each word was encased in a faint, heart-shaped border (i.e. weak pictorial element). The brand logo was positioned at the bottom right hand corner and the body copy was placed at
the top of the ad. The word ‘toothpaste’ was used as the cue for Condition 1 (Scent; Congruent) and Condition 3 (No Scent; Congruent). The word ‘shampoo’ was used for Condition 2 (Scent; Incongruent) and Condition 4 (No Scent; Incongruent). Table 1 below summarizes the combinations of olfactory stimuli and their corresponding cues in the ads.

Table 1
Study 1 - Olfactory and visual stimuli: congruent and incongruent cues

<table>
<thead>
<tr>
<th>Study 1 - Scent and Congruency</th>
<th>Olfactory Stimulus</th>
<th>Congruent Cue (Stimulus 1)</th>
<th>Incongruent Cue (Stimulus 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Pictorial Cue Ad</td>
<td>Lemon</td>
<td>Photograph of lemon</td>
<td>Photograph of banana</td>
</tr>
<tr>
<td>b) Textual Cue Ad</td>
<td>Mint</td>
<td>The word Toothpaste</td>
<td>The word Shampoo</td>
</tr>
</tbody>
</table>

*Experimental Procedure.* To test the aforementioned hypotheses, a Tobii T60 Eye Tracker (integrated into a 17” TFT monitor) was used to record the visual activity of our subjects. Each participant was first randomly assigned to one of four experimental conditions. After which, he was seated at a desk where five scent packets (labeled ‘1’ to ‘5’), a canister of coffee grounds and the eye-tracking monitor have been set up. For the scented conditions, the five scent packets contained filter paper that had been infused with essential oils. Scent #1 and #2 were our olfactory primers (i.e. lemon scent and mint scent, respectively) while Scent #3, #4 and #5 served as ‘dummy’ scents (e.g. strawberry scent and citrus scent) to correspond with our dummy ads. In the unscented conditions, the filter paper was not infused with any scent and was simply placed in the packet.

The eye tracker was then calibrated according to the individual’s height and position. Following the calibration exercise, the participant was told to carefully read the instructions on the screen: ‘You will be given a series of advertisements to look at. Before each ad appears, you will be prompted to pick up a scent packet labeled with a corresponding number (i.e. Ad #1 corresponds to Scent #1). Sniff the contents of the scent packet as you view each ad. Do note that the ads may not be presented in numerical order. Please ask the experimenter for help now if you have any questions. If not, press any key to continue.’
The participant then proceeded to view the ads on the monitor. Each ad revealed was first preceded by a prompt screen: ’You are about to view Ad #__. Please take two sniffs from the can of coffee grounds. Now, pick up Scent #__ and start to sniff its contents. Continue to sniff the scent as you are viewing the ad.’ This prompt was displayed for five seconds, after which the ad was shown. Respondents were instructed to smell coffee grounds between consecutive stimuli so that they could refresh their scent palettes and minimize contamination from smelling scents consecutively. According to Krishna, Lwin & Morrin (2010), smelling coffee grounds is an accepted practice in the fragrance industry to clear the nasal passage. The participant viewed a total of five ads, each lasting eight seconds on the monitor. Two out of the five were our test ads, while the other three served as dummy ads. The presentation order of the ads was randomized among subjects.

After the participant had completed the above task, he was provided with a short pen-and-paper questionnaire, and five folders labeled ‘1’ to ‘5’. These folders contained the five ads which were previously viewed. The questionnaire was primarily used to check the scent manipulation during the eye-tracking task. Referring to the ads provided in the folders, the participant was asked to rate on a seven-point scale his ability to detect a scent when he was looking at each advertisement during the eye-tracking task: ‘As I was viewing Ad #__ during the eye-tracking task, I was able to detect a scent’ (1 = Not at all, 7 = Most definitely). Finally, the participant’s demographic information was recorded.

**Measures: Fixation Count and Fixation Length.** During the experiment, the total number of eye fixations (fixation count) and total dwelling time of eye fixations on a particular cue (fixation length) were recorded. Fixation count is the frequency in which an individual fixates on the object. This measure has been associated with the degree of drawing attention (Lykins, Meana, & Kambe, 2006). Fixation length, on the other hand, represents the total time an individual fixates on a visual stimulus, and has been thought to indicate the
overall interest on a specific object (Lykins et al., 2006). Since the sizes of the cues were not identical between advertisements, we analyzed fixation data within demarcated areas-of-interest (AOIs) which contained the congruent/incongruent objects. These pre-determined AOIs were identical among the four experimental conditions.

**Study Two: Scent & Color Congruency**

*Sample.* 148 university students were recruited for Study Two in return for a token gift. Participants were ranged from 18 to 25 years old, comprising female and male individuals from different ethnic backgrounds. Only participants aged 25 and under were recruited for this eye-tracking study as past research has found that younger test subjects elicit eye-tracking measurements that are higher in quality than that of elderly subjects (Spooner, Sakala and Baloh, 1980).

*Design.* As illustrated in Figure 2 below, Study Two employed a 2 (scent versus no scent) x 2 (congruent color versus incongruent color) between-subjects factorial design. The four conditions are as follows: an ad with scent and a congruent color cue (Condition 1); an ad with scent and an incongruent color cue (Condition 2); an ad with the congruent cue used in Condition 1 but with no scent (Condition 3); and an ad with the incongruent color cue used in Condition 2 but with no scent (Condition 4).

<table>
<thead>
<tr>
<th>2 x 2: Scent &amp; Color Congruency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Congruent Color Cue</strong></td>
</tr>
<tr>
<td><strong>Scent</strong></td>
</tr>
<tr>
<td>Condition 1</td>
</tr>
<tr>
<td><strong>No Scent</strong></td>
</tr>
<tr>
<td>Condition 3</td>
</tr>
</tbody>
</table>

*Figure 2. Factorial Design for Study 2: Scent & Color*
**Materials: Olfactory Stimulus.** Strawberry scent was used as the olfactory stimulus. For each scent sample, two drops of essential oil were dripped carefully onto a sheet of filter paper measuring approximately 2”x 4”. This process left no permanent marks. Each filter paper was then sealed in a 3”x 4” airtight bag for 48 hours prior to the experiment to further infuse the scent into the filter paper.

**Materials: Visual Stimulus.** Two full-color print ads were designed for Study Two (Appendix B: Figure 3a and 3b). Both ads promoted a fictitious brand of food coloring, and included visuals of four food coloring bottles positioned in the four quadrants of the ad. The brand logo was placed at the bottom right hand corner while a short body copy was positioned at the top. For Condition 1 (Scent; Color Congruent) and Condition 3 (No Scent; Color Congruent), red food coloring was used as the cue, while grey food coloring was used for Condition 2 (Scent; Incongruent Color) and Condition 4 (No Scent; Incongruent Color). Similar to Study One, we wanted our ads to simulate realistic print advertisements and thus ensured that each stimulus contained all three ad elements - a brand, text and pictures (Pieters, Warlop and Wedel, 2002). We also organized elements according to Moriarty’s (1991) four main principles of ad functionality: unity, simplicity, contrast and balance.

**Experimental Procedure.** Study Two employed a similar procedure to Study One. A Tobii T60 Eye Tracker (integrated into a 17” TFT monitor) was used to record the visual activity of our subjects. Each participant was first randomly assigned to one of four experimental conditions. After which, he was seated at a desk where five scent packets (labeled ‘1’ to ‘5’), a canister of coffee grounds and the eye-tracking monitor have been set up. For the scented condition, the five scent packets contained filter paper that had been infused with essential oils. Scent #4 (strawberry scent) served as the olfactory primer while Scent #1, #2 #3 and #5 were used as ‘dummy’ scents (e.g. mint scent and citrus scent) to
correspond with the dummy ads. In the unscented conditions, the filter paper was not infused with any scent and was simply placed in the packet.

The eye tracker was then calibrated according to the individual’s height and position. Following the calibration exercise, the participant was told to carefully read the instructions on the screen: ‘You will be given a series of advertisements to look at. Before each ad appears, you will be prompted to pick up a scent packet labeled with a corresponding number (i.e. Ad #1 corresponds to Scent #1). Sniff the contents of the scent packet as you view each ad. Do note that the ads may not be presented in numerical order. Please ask the experimenter for help now if you have any questions. If not, press any key to continue.’

The participant then proceeded to view the ads on the monitor. Each ad revealed was first preceded by a prompt screen: ‘You are about to view Ad #___. Please take two sniffs from the can of coffee grounds. Now, pick up Scent #__ and start to sniff its contents. Continue to sniff the scent as you are viewing the ad.’ This prompt was displayed for five seconds, after which the ad was shown. Respondents were instructed to smell coffee grounds between consecutive stimuli so that they could refresh their scent palettes and minimize contamination from smelling scents consecutively. According to Krishna, Lwin and Morrin (2010), smelling coffee grounds is an accepted practice in the fragrance industry to clear the nasal passage. The participant viewed a total of five ads, each lasting eight seconds on the monitor. One out of the five ads was our test ad, while the other four served as dummy ads. The presentation order of the ads was randomized among subjects.

After the participant had completed the above task, he was provided with a pen-and-paper questionnaire, five scent packets (similar to the ones used during the eye-tracking task), and five folders labeled ‘1’ to ‘5’. These folders contained the five ads which were viewed during the eye-tracking task.
The questionnaire first asked the participant to refer to the given scents and ads in the folders (e.g. ‘Please examine the advertisement in Folder #1 and take at least two sniffs of Scent #1’). After which, he was instructed to complete a series of seven-point semantic differentials in which his purchase intention was measured. The participant was then asked to rate on a seven-point scale his ability to detect a scent when he was looking at each advertisement during the eye-tracking task: ‘As I was viewing Ad #__ during the eye-tracking task, I was able to detect a scent (1 = Not at all, 7 = Most definitely)’. Finally, the participant’s demographic information was recorded.

**Measures: Fixation Count and Fixation Length.** Similar to Study One, the total number of eye fixations (fixation count) and total dwelling time of eye fixations on a particular cue (fixation length) were recorded during the experiment. Fixation count is the frequency in which an individual fixates on the object and has been associated with the degree of drawing attention (Lykins et al., 2006). Fixation length, on the other hand, represents the total time an individual fixates on a visual stimulus, and has been thought to indicate the overall interest on a specific object (Lykins et al., 2006). Since the sizes of the cues were not identical between advertisements, we analyzed fixation data within demarcated areas-of-interest (AOIs) which contained the congruent/incongruent objects. These pre-determined AOIs were identical among the four experimental conditions.

**Measures: Purchase Intention.** This three-item scale (Cronbach $\alpha = 0.975$) was adapted from Putrevu and Lord’s (1994) study on comparative advertising and was operationalized as the degree to which a consumer intends to buy a specified brand or product in the future. Each item from this measure was a seven-point semantic differential scale responding to the statement: ‘Rate the probability that you would purchase the product advertised’. Table 2 provides a summary of the items used in this construct. Moreover, in conducting a factor analysis, we confirm that all items had factor loadings of above 0.50.
Table 2

Study 2: Measurement items (Semantic Differentials) for Purchase Intention

<table>
<thead>
<tr>
<th>Measurement Items</th>
<th>Rate the probability that you would purchase the product advertised.</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Intention</td>
<td>Unlikely Unlikely Vs. Likely</td>
<td>0.975</td>
</tr>
<tr>
<td></td>
<td>Improbable Improbable Vs. Probable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impossible Impossible Vs. Possible</td>
<td></td>
</tr>
</tbody>
</table>

Study Three: Scent & Semantic Congruency

*Sample.* For Study Three, 148 university students were recruited in return for a token gift. Subjects were aged 18 to 25, comprising both female and male individuals from varied ethnic backgrounds. As earlier mentioned, past research has found that younger subjects exhibit eye-tracking measurements that are better in quality than that of elderly subjects ( Spooner, Sakala and Baloh, 1980). Thus, only participants aged 25 and under were recruited.

*Design.* As shown in Figure 3, Study Three employed a 2 (scent versus no scent) x 2 (semantically congruent versus semantically incongruent) between-subjects factorial design. The four conditions are as follows: an ad with scent and a semantically congruent cue (Condition 1); an ad with scent and a semantically incongruent cue (Condition 2); an ad with the semantically congruent cue used in Condition 1 but with no scent (Condition 3); and an ad with the semantically incongruent cue used in Condition 2 but with no scent (Condition 4).

![Figure 3. Factorial Designs for Study Three: Scent and Semantic Congruency](image-url)
**Materials: Olfactory Stimulus.** Citrus scent was used as the olfactory stimulus in Study Three. For each scent sample, two drops of essential oil were dripped carefully onto a sheet of filter paper measuring approximately 2”x 4”. This process left no permanent marks. Each filter paper was then sealed in a 3”x 4” airtight bag for 48 hours prior to the experiment to further infuse the scent into the filter paper.

**Materials: Visual Stimuli.** Similar to the previous two studies, we wanted our ads to simulate realistic print advertisements and thus ensured that each stimulus contained all three ad elements - a brand, text and pictures (Pieters, Warlop & Wedel, 2002). In ads that tested congruency to *pictorial* cues, a brand element, a heavy pictorial element and a weak textual element were included. For ads that tested congruency to *textual* cues, we incorporated the brand element, a heavy textual element and a weak pictorial element. We also organized our elements according to Moriarty’s (1991) four main principles of ad functionality: unity, simplicity, contrast and balance.

Four full-color print advertisements were created, consisting of two main designs (one for pictorial and one for textual). For the pictorial design (Appendix B: Figures 4a and 4b), the ad promoted a fictitious household superstore, and consisted of four visuals featuring furniture/appliances positioned in the four quadrants of the ad. The brand logo was placed at the head of the ad while a brief body copy was divided between the top and bottom portions of the ad. For Condition 1 (Scent; Semantically Congruent) and Condition 3 (No Scent; Semantically Congruent), a picture of a woman cleaning was used as the cue, while a picture of a woman arranging books on a shelf was used for Condition 2 (Scent; Semantically Incongruent) and Condition 4 (No Scent; Semantically Incongruent).

In the textual design (Appendix B: Figures 5a and 5b), the ad promoted a fictitious Taekwondo school, and included four separate words relating to daily activities. The words were arranged alternately (i.e. weak pictorial element) while the brand logo and body copy
were positioned at the bottom portion of the ad. The word ‘Clean’ was used as the cue for Condition 1 (Scent; Semantically Congruent) and Condition 3 (No Scent; Semantically Congruent). The word ‘Walk’ was used for Condition 2 (Scent; Semantically Incongruent) and Condition 4 (No Scent; Semantically Incongruent). Table 3 below summarizes the olfactory and visual stimuli used in Study Three.

**Table 3**

*Study 3 - Olfactory and visual stimuli: congruent and incongruent cues*

<table>
<thead>
<tr>
<th>Study 3 - Scent and Semantic Congruency</th>
<th>Olfactory Stimulus</th>
<th>Congruent Cue (Stimulus 1)</th>
<th>Incongruent Cue (Stimulus 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Pictorial Cue Ad</td>
<td>Citrus</td>
<td>Photograph of woman cleaning</td>
<td>Photograph of woman arranging books</td>
</tr>
<tr>
<td>b) Textual Cue Ad</td>
<td>Citrus</td>
<td>The word <em>Clean</em></td>
<td>The word <em>Walk</em></td>
</tr>
</tbody>
</table>

**Experimental Procedure.** Study Three employed a similar procedure to Study One (please see page 30). However, in this study, Scent #3 and #5 were our olfactory primers (both using citrus scent) while Scent #1, #2 and #4 served as ‘dummy’ scents (e.g. strawberry scent and lemon scent) to correspond with our dummy ads.

**Measures: Fixation Count and Fixation Length.** Similar to Study One and Two, the total number of eye fixations (fixation count) and total dwelling time of eye fixations on a particular cue (fixation length) were recorded during the experiment. Fixation count is the frequency in which an individual fixates on the object. This measure has been associated with the degree of drawing attention (Lykins et al., 2006). Fixation length, on the other hand, represents the total time an individual fixates on a visual stimulus, and has been thought to indicate the overall interest on a specific object (Lykins et al., 2006). Since the sizes of the cues were not identical between advertisements, we analyzed fixation data within demarcated areas-of-interest (AOIs) which contained the congruent/incongruent objects. These pre-determined AOIs were identical among the four experimental conditions.
Data Analysis and Findings

This chapter first describes the sample profile of the respondents and the results of the manipulation checks. This is followed by a discussion of the ANOVA findings and the testing of hypotheses. A summary of results will be provided at the end of the chapter.

Sample Profile

For Study One, Two and Three, 148 university students were recruited in return for a token gift. Participants were aged 18 to 25, comprising both female (81.8%) and male (12.8%) undergraduates from varied ethnic backgrounds. 83.8% were Chinese, while Malays (7.4%), Indians (6.1%), Eurasians (0.7%) and other races (2.0%) formed the remainder of participants.

Manipulation Checks

Manipulation checks were conducted across the three studies to test whether or not subjects detected a scent. ANOVA results revealed that all manipulations were successful. For Study 1, the main effect of scent on its manipulation was significant for both the pictorial ad \( F(1, 146) = 922.98, p < .001 \) and textual ad \( F(1, 146) = 873.33, p < .001 \). In addition, the means were in the expected direction for the pictorial ad: \( M_{scent} = 6.11 \) (SD = .96) versus \( M_{no-scent} = 1.66 \) (SD = .82); as well as textual ad: \( M_{scent} = 6.05 \) (SD = 1.08) vs. \( M_{no-scent} = 1.50 \) (SD = .76). For Study 2, the main effect of scent was significant \( F(1, 146) = 1176.55, p < .001 \) and the means were in the expected direction with \( M = 6.19 \) (SD = .90) for the scent condition and \( M = 1.53 \) (SD = .74) for the no-scent condition. In Study 3, the main effect of scent on its manipulation was significant for both Ad 3 \( F(1, 146) = 827.05, p < .001 \) and Ad 5 \( F(1, 146) = 1167.70, p < .001 \). Similarly, the means were in the expected direction for Ad 3: \( M_{scent} = 5.97 \) (SD = 1.03) versus \( M_{no-scent} = 1.54 \) (SD = .83) and Ad 5: \( M_{scent} = 6.16 \) (SD = .92) versus \( M_{no-scent} = 1.50 \) (SD = .72).
Study One: Scent and Congruency

Study One aimed to determine whether or not a scent affected one’s visual attention towards a congruent pictorial or textual cue in an advertisement. The following paragraphs will discuss our findings for this study.

Two-way ANOVA Results

Fixation Length: Pictorial and Textual Cues. We conducted a two-way ANOVA on fixation length (i.e. total dwelling time of eye fixations on a particular cue) as a function of scent condition, congruency, and their interaction. For pictorial cues, there was a significant main effect of scent \(F(1, 144) = 36.04, p < 0.001\], and congruency \(F(1, 144) = 24.28, p < 0.001\], qualified by a significant interaction of scent and congruency \(F(1, 144) = 24.18, p < 0.001\]. For textual cues, there was also a significant main effect of scent \(F(1, 144) = 29.33, p < 0.001\] and congruency \(F(1, 144) = 18.93, p < 0.001\]. There was also a significant interaction between scent and congruency \(F(1, 144) = 12.06, p < 0.01\].

Fixation Count: Pictorial and Textual Cues. A two-way ANOVA was also conducted on fixation count (i.e. frequency in which an individual fixates on a particular cue) as a function of scent condition, congruency, and their interaction. For pictorial cues, there was a significant main effect of scent \(F(1, 144) = 48.80, p < 0.001\], congruency \(F(1, 144) = 30.63, p < 0.001\], qualified by a significant interaction of scent and congruency \(F(1, 144) = 21.41, p < 0.001\]. For textual cues, there was also a significant main effect of scent \(F(1, 144) = 23.07, p < 0.001\] and congruency \(F(1, 144) = 12.02, p < 0.01\]. However, no significant interaction effect was found \(F(1, 144) = 2.65, p = 0.106\]. Table 4 illustrates the summary of ANOVA results on fixation length and fixation count.
Table 4

**Study 1: 2-way ANOVA results on Fixation Length and Fixation Count**

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Univariate Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixation Length</td>
</tr>
<tr>
<td></td>
<td>Pictorial</td>
</tr>
<tr>
<td></td>
<td>$F$</td>
</tr>
<tr>
<td>Scent</td>
<td>36.04</td>
</tr>
<tr>
<td>Congruency</td>
<td>24.28</td>
</tr>
<tr>
<td>Scent*Congruency</td>
<td>24.18</td>
</tr>
</tbody>
</table>

*p <0.05, ** p <0.01

*Heat Maps for Fixation Count.* Figures 4 and 5 show heat-maps comparing fixation counts between the four experimental conditions. Each heat map depicts the total number of fixations from all 37 participants in that condition. Fixations are recorded on a color gradient, with red indicating the highest count (i.e. highest number of fixations) and green indicating the lowest. AOI refers to the demarcated area of interest – the part of the advertisement containing the congruent/incongruent object. As seen in both figures, Condition 1 (Scent; Congruent Cue) recorded the highest frequency of fixations within its AOIs for both pictorial and textual cues.

**Figure 4.** Study 1: Heat-maps comparing Fixation Count on Areas of Interest (Pictorial Cues)
THE IMPACT OF SCENT ON VISUAL ATTENTION

Figure 5. Study 1: Heat-maps comparing Fixation Count on Areas of Interest (Textual Cues)

Follow-Up Tests and Hypothesis Testing

Fixation Length: Pictorial and Textual Cues. We predicted in H1a that in the presence of a scent, the subject will spend a longer time fixating on a congruent pictorial cue as compared to an incongruent pictorial cue. Similarly, H2a proposed that the presence of a scent will result in the subject spending a longer time fixating on a congruent textual cue as compared to an incongruent textual cue.

Having found significant interaction effects between scent and congruency on fixation length, we proceeded with follow-up tests to confirm whether or not there were indeed significant differences between the treatment (scent) and the control (no-scent) condition within the same level of congruency (more specifically, within Stimulus 1 - the ‘congruent’ condition). Table 5 gives an overview of the cell means for fixation length and fixation count while Figure 6 illustrates their respective means on a plot graph.

Table 5
Study 1: Cell Means for Fixation Length and Fixation Count by Scent & Congruency

<table>
<thead>
<tr>
<th></th>
<th>Fixation Length</th>
<th>Fixation Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pictorial</td>
<td>Textual</td>
</tr>
<tr>
<td></td>
<td>Stimulus 1</td>
<td>Stimulus 2</td>
</tr>
<tr>
<td></td>
<td>Congruent</td>
<td>Incongruent</td>
</tr>
<tr>
<td>Scent</td>
<td>1.621</td>
<td>0.421</td>
</tr>
<tr>
<td>No Scent</td>
<td>0.290</td>
<td>0.289</td>
</tr>
<tr>
<td>Delta</td>
<td>1.331</td>
<td>0.098</td>
</tr>
<tr>
<td>t-value</td>
<td>5.97**</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>4.757</td>
<td>1.729</td>
</tr>
<tr>
<td></td>
<td>1.297</td>
<td>1.027</td>
</tr>
<tr>
<td></td>
<td>3.459</td>
<td>0.703</td>
</tr>
<tr>
<td></td>
<td>6.78**</td>
<td>2.28*</td>
</tr>
</tbody>
</table>

* p <0.05, ** p <0.01
We also compared the cell means for fixation length between stimuli within the scented condition. For pictorial cues, we found that fixation length was significantly greater when the cue was congruent \((M_{\text{Stimulus1}} = 1.62, SD = 1.29 \text{ vs. } M_{\text{Stimulus2}} = 0.42, SD = 0.37; t(42) = 5.43, p < 0.001\)\). The same was also found for textual cues \((M_{\text{Stimulus1}} = 2.00, SD = 1.30 \text{ vs. } M_{\text{Stimulus2}} = 0.98, SD = 0.50; t(46) = 4.45, p < 0.001\)\). The results from the 2-way ANOVAs and follow-up means test collectively suggest that in the presence of a scent, fixation length on a pictorial or textual cue was significantly greater when the cue was congruent to the scent (as opposed to when the cue was incongruent). Thus, H1a and H2a are supported.
Fixation Count: Pictorial and Textual Cues. H1b proposed that in the presence of a scent, the subject will fixate more frequently on a congruent pictorial cue as compared to an incongruent pictorial cue. Correspondingly, H2b predicted that the presence of a scent will result in the subject fixating more frequently on a congruent textual cue as compared to an incongruent textual cue.

As previously discussed, the 2-way ANOVAs revealed a significant interaction effect on fixation count for pictorial cues, but not for textual cues (see Table 4). We thus proceeded with follow-up tests for pictorial cues to determine whether or not there were significant differences between the treatment (scent) and the control (no-scent) condition within the same level of congruency. As seen in Figure 6 and Table 5, when comparing the cell means for fixation count within Stimulus 1 - Pictorial, fixation count was significantly higher in the presence of a scent ($M_{scent} = 4.76$, $SD = 2.68$ vs. $M_{no-scent} = 1.30$, $SD = 1.56$; $t(57) = 6.78$, $p < 0.001$). We also compared the cell means for fixation count between stimuli within the scented condition and found that fixation count was significantly greater when the pictorial cue was congruent ($M_{Stimulus1} = 4.76$, $SD = 2.68$ vs. $M_{Stimulus2} = 1.73$, $SD = 1.39$; $t(53) = 6.10$, $p < 0.001$).

The results from the 2-way ANOVAs and follow-up means test suggest that in the presence of a scent, fixation count on a pictorial cue was significantly higher when the cue was congruent to the scent (as opposed to when the cue was incongruent). Therefore, H1b is supported.

With regard to textual cues, however, the 2-way ANOVA revealed no significant interaction effect. Therefore, while the cell mean for Condition 1 (scent; congruent textual cue) was higher than that of the other conditions, scent and congruency did not interact to product an amplified effect on fixation count. Hence, H2b is not fully supported.
**Study 2: Scent and Color Congruency**

Study 2 aimed to determine whether or not scent affected one’s visual attention towards a cue of a congruent color in the context of an advertisement. The following paragraphs will discuss our findings for this study.

**Two-way ANOVA Results**

*Fixation Length & Fixation Count.* A two-way ANOVA was conducted on fixation length as a function of scent condition, color congruency, and their interaction. Results revealed a significant main effect of scent \([F (1, 144) = 21.36, p <0.001]\) and a significant main effect of congruency \([F (1, 144) = 26.91, p <0.001]\), qualified by a significant interaction of scent and congruency \([F (1, 144) = 9.05, p <0.01]\). For fixation count, results showed that there was a significant main effect of scent \([F (1, 144) = 16.84, p <0.001]\) and a significant main effect of congruency \([F (1, 144) = 27.35, p <0.001]\). However, no significant interaction effect was found between scent and congruency \([F (1, 144) = 1.66, p = 0.200]\). A summary of ANOVA results can be seen in Table 6.

**Table 6**

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Fixation Length</th>
<th>Fixation Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(F)</td>
<td>Sig.</td>
</tr>
<tr>
<td>Scent</td>
<td>21.36</td>
<td>0.000**</td>
</tr>
<tr>
<td>Color Congruency</td>
<td>26.91</td>
<td>0.000**</td>
</tr>
<tr>
<td>Scent*Congruency</td>
<td>9.05</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

* p <0.05. ** p <0.01

*Purchase Intention.* We also conducted a two-way ANOVA on purchase intention as a function of scent condition, color congruency, and their interaction. Results revealed a significant main effect of congruency \([F (1, 144) = 12.02, p <0.01]\) and a significant interaction effect by scent and color congruency \([F (1, 144) = 6.23, p <0.05]\). There was no significant main effect of scent \([F (1, 144) = 0.62, p =0.433]\).
Heat Maps for Fixation Count. Figure 7 shows heat-maps comparing the frequency of fixations between the four conditions. Each heat map is an aggregate of the total number of fixations from all 37 participants in one condition. Fixation counts are recorded on a color gradient, with red indicating the highest count and green indicating the lowest. AOI refers to the demarcated area of interest, or the part of the advertisement containing the congruent/incongruent object. As shown in the figure, Condition 1 (Scent; Congruent Color Cue) recorded the highest fixation count within its AOI.

![Heat Maps](image)

**Figure 7. Study 2: Heat-maps comparing Fixation Count on Areas of Interest**

Follow-Up Tests and Hypothesis Testing

Fixation Length. We predicted in H3a that in the presence of a scent, the subject will spend a longer duration fixating on a cue of a congruent color as compared to a cue of an incongruent color. Having established a significant interaction effect between scent and congruency on fixation length, we proceeded with follow-up tests to determine whether or not there were significant differences between the treatment (scent) and the control (no-scent) condition within the same level of congruency (specifically, within Stimulus 1 - the ‘color congruent’ condition). As illustrated by Figure 8 and Table 7, in comparing the cell means for fixation length within Stimulus 1, fixation length was significantly greater in the presence of a scent ($M_{scent} = 1.73, SD = 1.65$ vs. $M_{no-scent} = 0.56, SD = 0.60$; $t(45) = 4.02, p < 0.001$). We also compared the cell means between stimuli within the scented condition, and found that
fixation length was significantly greater when the cue was color congruent ($M_{Stimulus1} = 1.73$, $SD = 1.65$ vs. $M_{Stimulus2} = 0.48$, $SD = 0.47$; $t(41) = 4.42$, $p < 0.001$).

The results from the 2-way ANOVAs and follow-up means test propose that in the presence of a scent, fixation length on a color cue was significantly increased when the cue was congruent to the scent (as opposed to when the cue was incongruent). Thus, H3a is supported.

Table 7

| Study 2: Cell Means for Fixation Length and Fixation Count by Scent & Color Congruency |
|-----------------------------------------------|-----------------------------------------------|
| Fixation Length                              | Fixation Count                                |
| Stimulus 1 Congruent                         | Stimulus 2 Congruent                          |
| Scent                                         | No Scent                                      |
| 1.725                                         | 0.563                                         |
| 0.477                                         | 0.232                                         |
| 3.973                                         | 2.162                                         |
| 1.784                                         | 0.838                                         |
| 1.811                                         | 0.946                                         |
| 4.02**                                        | 2.55*                                         |
| Delta                                         | 4.02**                                        |
| 0.477                                         | 0.563                                         |
| 1.725                                         | 0.477                                         |
| 0.477                                         | 0.232                                         |
| 2.162                                         | 0.838                                         |
| 1.811                                         | 0.946                                         |
| 3.017*                                        | 3.135*                                        |

* $p < 0.05$, ** $p < 0.01$

**Figure 8.** Study 2: Means Plot of Scent & Color Congruency on Fixation Length

*Fixation Count.* H3b proposed that in the presence of a scent, the subject will fixate more frequently on a congruent color cue as compared to an incongruent color cue. However, the 2-way ANOVA revealed no significant interaction effect on fixation count by scent and color congruency. Therefore, while the cell mean for Condition 1 (scent; congruent color cue) was higher than that of the other conditions, scent and color congruency did not interact to produce an increased effect on fixation count. Hence, the results do not fully support H3b.
**Purchase Intention.** H3c proposed that a scented ad that contains a congruent color cue will elicit a higher likelihood to purchase than an ad that contains an incongruent color cue. Having established a significant interaction between scent and color congruency previously, we proceeded with follow-up means tests.

As shown in Table 8 and Figure 9, when comparing the cell means for fixation length within Stimulus 1, purchase intention was significantly greater in the presence of a scent ($M_{scent} = 4.44, SD = 1.70$ vs. $M_{no-scent} = 3.56, SD = 1.81; t(72) = 2.17, p < 0.05$). We also compared the cell means between stimuli within the scented condition, and found that purchase intention was significantly greater when the cue was color congruent ($M_{Stimulus1} = 4.44, SD = 1.70$ vs. $M_{Stimulus2} = 2.84, SD = 1.48; t(72) = 4.33, p < 0.001$). The results from the 2-way ANOVA and follow-up means test propose that a scented ad that contains a congruent color cue elicits a greater purchase intention than an ad that contains an incongruent color cue. Thus, H3c is supported.

![Figure 9. Study 2: Means Plot of Scent & Color Congruency on Purchase Intention](image)

**Table 8**

*Study 2: Cell Means for Purchase Intention by Scent & Color Congruency*

<table>
<thead>
<tr>
<th>Purchase Intention</th>
<th>Stimulus 1</th>
<th>Stimulus 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Congruent</td>
<td>Incongruent</td>
</tr>
<tr>
<td>Scent</td>
<td>4.441</td>
<td>2.838</td>
</tr>
<tr>
<td>No Scent</td>
<td>3.559</td>
<td>3.297</td>
</tr>
<tr>
<td>Delta</td>
<td>0.883</td>
<td>-0.459</td>
</tr>
<tr>
<td>$t$-value</td>
<td>2.168*</td>
<td>-1.307</td>
</tr>
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</table>

* $p <0.05$, **$p <0.01$
Study 3: Scent and Semantic Congruency

Study 3 aimed to determine whether or not scent affected one’s visual attention towards a semantically congruent visual cue or textual cue in the context of an advertisement. The following paragraphs will discuss our findings for this study.

Two-way ANOVA Results

Fixation Length: Pictorial and Textual Cues. A two-way ANOVA was conducted on fixation length as a function of scent, semantic congruency, and their interaction. For pictorial cues, there was a significant main effect of scent \( F(1, 144) = 34.72, p <0.001 \), and a significant main effect of congruency \( F(1, 144) = 13.69, p <0.001 \), qualified by a significant interaction of scent and congruency \( F(1, 144) = 11.47, p <0.01 \). For textual cues, there was also a significant main effect of scent \( F(1, 144) = 6.96, p <0.01 \), a significant main effect of congruency \( F(1, 144) = 6.44, p <0.05 \), and a significant interaction between scent and congruency \( F(1, 144) = 9.243, p <0.01 \).

Fixation Count: Pictorial and Textual Cues. Another two-way ANOVA was conducted on fixation count as a function of scent condition, semantic congruency, and their interaction. For pictorial cues, there was a significant main effect of scent \( F(1, 144) = 21.45, p <0.001 \), congruency \( F(1, 144) = 4.46, p <0.05 \) and a significant interaction between congruency and scent \( F(1, 144) = 5.94, p <0.05 \). For textual cues, there was a significant main effect of congruency \( F(1, 144) = 5.71, p <0.05 \) and a significant interaction between scent and congruency \( F(1, 144) = 9.52, p <0.01 \). However, there was no significant main effect of scent on fixation count \( F(1, 144) = 0.63, p =0.427 \). Table 9 illustrates the summary of ANOVA results for fixation length and fixation count.
Table 9

**Study 3: 2-way ANOVA results on Fixation Length and Fixation Count**

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Univariate Results</th>
<th>Fixation Count</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fixation Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pictorial</td>
<td>Textual</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( F )   Sig.</td>
<td>( F )   Sig.</td>
<td></td>
</tr>
<tr>
<td>Scent</td>
<td>34.71 0.000**</td>
<td>6.96 0.009*</td>
<td></td>
</tr>
<tr>
<td>Congruency</td>
<td>13.69 0.000**</td>
<td>6.44 0.012*</td>
<td></td>
</tr>
<tr>
<td>Scent*Congruency</td>
<td>11.47 0.001*</td>
<td>9.24 0.003*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( F )   Sig.</td>
<td>( F )   Sig.</td>
<td></td>
</tr>
<tr>
<td>Pictorial</td>
<td>21.45 0.036*</td>
<td>0.63 0.427</td>
<td></td>
</tr>
<tr>
<td>Textual</td>
<td>4.46 0.000**</td>
<td>5.71 0.018*</td>
<td></td>
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<tr>
<td>Scent*Congruency</td>
<td>5.94 0.016*</td>
<td>9.52 0.002*</td>
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</table>

\* \( p < 0.05 \), ** \( p < 0.01 \)

Heat Maps for Fixation Count. Figures 10 and 11 depict heat-maps comparing the frequency of fixations between the four conditions. Each heat map consolidates the total number of fixations from all 37 participants in one condition. AOI refers to the demarcated area of interest, or the part of the advertisement containing the congruent/incongruent object. Fixation counts are recorded on a color gradient, with red indicating the highest count and green being the lowest. As seen in the figures, Condition 1 (Scent; Congruent Cue) recorded the highest count of fixations within its AOIs for both pictorial and textual cues.

**Figure 10.** Study 3: Heat-maps comparing Fixation Count on Areas of Interest (Pictorial Cues)
THE IMPACT OF SCENT ON VISUAL ATTENTION

Figure 11. Study 3: Heat-maps comparing Fixation Count on Areas of Interest (Textual Cues)

Follow-Up Tests and Hypothesis Testing

Fixation Length: Pictorial and Textual Cues. We predicted in H4a that in the presence of a scent, the subject will spend a longer time fixating on a semantically congruent pictorial cue as compared to a semantically incongruent pictorial cue. Similarly, H5a proposed that the presence of a scent will result in the subject spending a longer time fixating on a semantically congruent textual cue as compared to an incongruent one. Having found significant interaction effects between scent and congruency on fixation length, we proceeded with follow-up tests to determine whether there were indeed significant differences between the treatment (scent) and the control (no-scent) condition within the same level of congruency (more specifically, within Stimulus 1 - the ‘semantically congruent’ condition).

Table 10

<table>
<thead>
<tr>
<th>Fixation Count</th>
<th>Pictorial</th>
<th>Textual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Scent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p <0.05, ** p <0.01
Figure 12. Study 3: Means Plot of Scent & Congruency on Fixation Length & Count

As illustrated by Figure 12 and Table 10, when comparing the cell means for fixation length within Stimulus 1 - Pictorial, fixation length was significantly greater in the presence of a scent ($M_{scent} = 1.63$, $SD = 1.13$ vs. $M_{no-scent} = 0.55$, $SD = 0.42$; $t(45) = 5.945$, $p < 0.001$). Similarly, when comparing the cell means for fixation length within Stimulus 1 - Textual, fixation length was significantly more when a scent was present ($M_{scent} = 1.20$, $SD = 1.29$ vs. $M_{no-scent} = 0.46$, $SD = 0.41$; $t(43) = 3.31$, $p < 0.01$).

We also compared the cell means for fixation length between stimuli within the scented condition. For pictorial cues, we found that fixation length was significantly greater when the cue was congruent ($M_{Stimulus1} = 1.63$, $SD = 1.13$ vs. $M_{Stimulus2} = 0.81$, $SD = 0.56$; $t(52) = 3.97$, $p < 0.001$). The same was also found for textual cues ($M_{Stimulus1} = 1.20$, $SD = 1.29$ vs. $M_{Stimulus2} = 0.47$, $SD = 0.62$; $t(72) = 3.07$, $p < 0.01$). The results from the 2-way ANOVAs and follow-up means test collectively suggest that in the presence of a scent,
fixation length on a pictorial or textual cue was significantly greater when the cue was semantically congruent to the scent (as opposed to when the cue was incongruent). Thus, H4a and H5a are supported.

*Fixation Count: Pictorial and Textual Cues.* H4b proposed that in the presence of a scent, the subject will fixate more frequently on a semantically congruent pictorial cue as compared to an incongruent pictorial cue. Correspondingly, H5b predicted that the presence of a scent will result in the subject fixating more frequently on a semantically congruent textual cue as compared to an incongruent one. Follow-up tests confirmed that there were significant differences between the treatment (scent) and the control (no-scent) condition within the same level of congruency (with regards to Stimulus 1). As illustrated by Figure 12 and Table 10, when comparing the cell means for fixation count within Stimulus 1 - Pictorial, fixation count was significantly higher in the presence of a scent ($M_{scent} = 4.51, SD = 2.46$ vs. $M_{no-scent} = 2.16, SD = 1.59; t(61) = 4.89, p < 0.001$). The same was found for Stimulus 1-Textual ($M_{scent} = 2.86, SD = 1.75$ vs. $M_{no-scent} = 1.81, SD = 1.44; t(72) = 2.82, p < 0.01$).

We also compared the cell means for fixation count between stimuli *within* the scented condition. For pictorial cues, we found that fixation count was significantly greater when the cue was congruent ($M_{Stimulus1} = 4.51, SD = 2.46$ vs. $M_{Stimulus2} = 3.00, SD = 1.90; t(72) = 2.97, p < 0.01$). The same was also found for textual cues ($M_{Stimulus1} = 2.86, SD = 1.75$ vs. $M_{Stimulus2} = 1.38, SD = 1.42; t(72) = 4.01, p < 0.001$).

As discussed in the previous section, the 2-way ANOVA conducted on fixation count revealed a significant interaction effect between scent and congruency (see Table 9). The combined results of the 2-way ANOVA and follow-up means test propose that in the presence of a scent, fixation count on a pictorial or textual cue was significantly higher when the cue was semantically congruent to the scent (as opposed to when the cue was semantically incongruent). Therefore, H4b and H5b are supported.
## Summary of Hypotheses Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Supported?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H1a:</strong> In the presence of a scent, the subject will spend a longer time fixing on a congruent pictorial cue as compared to an incongruent pictorial cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H1b:</strong> In the presence of a scent, the subject will fixate more frequently on a congruent pictorial cue as compared to an incongruent pictorial cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H2a:</strong> In the presence of a scent, the subject will spend a longer time fixing on a congruent textual cue as compared to an incongruent textual cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H2b:</strong> In the presence of a scent, the subject will fixate more frequently on a congruent textual cue as compared to an incongruent textual cue.</td>
<td>No</td>
</tr>
<tr>
<td><strong>H3a:</strong> In the presence of a scent, the subject will spend a longer time fixing on a cue of a congruent color as compared to a cue of an incongruent color.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H3b:</strong> In the presence of a scent, the subject will fixate more frequently on a cue of a congruent color as compared to a cue of an incongruent color.</td>
<td>No</td>
</tr>
<tr>
<td><strong>H3c:</strong> A scented ad that contains a congruent color cue will elicit a higher likelihood to purchase than an ad that contains an incongruent color cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H4a:</strong> In the presence of a scent, the subject will spend a longer time fixing on a semantically congruent pictorial cue as compared to a semantically incongruent pictorial cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H4b:</strong> In the presence of a scent, the subject will fixate more frequently on a semantically congruent pictorial cue as compared to an incongruent pictorial cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H5a:</strong> In the presence of a scent, the subject will spend a longer time fixing on a <em>semantically</em> congruent textual cue as compared to a semantically incongruent textual cue.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>H5b:</strong> In the presence of a scent, the subject will fixate more frequently on a semantically congruent textual cue as compared to an incongruent textual cue.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Discussion

Our study aimed to establish whether or not scent can direct visual attention towards specific cues in an advertisement. In light of the above results, the main trend revealed was that a scent does possess the ability to direct visual focus, and can enhance attention towards particular cues if they are congruent with the scent.

In Study One, we set out to explore the effects of scent and direct congruency on visual attention towards pictorial and textual cues in an advertisement. For pictorial cues, the results of the 2-way ANOVA supported both H1a and H1b, in that the pairing of a pictorial cue with a congruent scent resulted in longer fixation lengths and higher fixation counts - in other words, a greater degree of attention. This finding is supported in our literature review, which proposed that scents may have the ability to augment visual attention towards corresponding cues because selective visual attention, in this instance, is goal-driven. (Pieters & Wedel, 2007; Rayner et al. 2001; Rayner et al. 2008; Yarbus, 1967) Because individuals are constantly identifying objects in their external world, the introduction of a scent may drive individuals to connect the odor with surrounding objects in an attempt to label and identify the scent. Eye fixations, as a result, get directed to and become clustered in ‘informative regions’ (i.e. the congruent object) in an attempt to assist the individual in completing his odor-identification goal.

An interesting finding was revealed in our test for textual cues. While a textual cue, when paired with a congruent scent, resulted in longer fixation lengths (H2a), it did not result in significantly higher fixation counts (H2b). A possible explanation for this is that textual cues are saliently less attention-grabbing than pictorial cues. As a result, subjects may be less likely to pay stimulus-driven attention (i.e. visual attention stemming from salient attributes in a cue) to textual cues, as compared to pictorial cues.
Study Two aimed to examine the impact of scent and color congruency on visual attention. Our findings showed that fixation length on a color cue was significantly higher when it was perceived to be congruent to the scent (H3a). This is largely supported by our literature review, which explained that odors can evoke characteristic colour hues and that humans cognitively attach certain fixed colours to particular scents (Gilbert, Martin & Kemp, 1996). In addition to exploring the impact of scent and color on visual attention, Study Two also sought to examine the effects of scent and color congruency on purchase intention. Two-way ANOVA results revealed that purchase intention for the product advertised was significantly higher when the ad was viewed in the presence of a scent and the ad contained a color congruent cue (as opposed to an incongruent cue). This finding is supported by existing literature, which explains that colors have the ability to affect people’s feelings and increase levels of arousal (Gorn, Chattopadhyay, Yi & Dahl, 1997), in turn leading to enhanced buying behaviour (Sherman et al., 1997).

In Study Three, we set out to explore the effects of scent and semantic congruency on visual attention. Our findings revealed that fixation length and count were significantly higher for both pictorial (H4a, H4b) and textual cues (H5a, H5b) when they were semantically congruent to the scent. Existing associative learning theories, such as the Classical-Conditioning paradigm and the Theory of Odor-Associative Learning support this finding. The latter theory, for example, states that once an individual experiences an odor, the context (place, situation, person or event) in which he perceives it and its emotional value becomes attached to that aroma (Herz, 2007). It is plausible that during our study, the citrus scent that was introduced evoked an idea or notion of ‘cleaning’ in our participants’ minds because they had previously been acquainted with a similar scent when using household cleaning products. With this notion or idea in their minds, participants were then subjected to semantic priming, a process by which combinatorial semantics direct visual attention towards
semantically relevant objects in the visual environment (Kamide et al., 2003). In other words, participants were inclined to fixate upon objects that were semantically congruent with the image or idea formed in their minds (in this instance, the picture of the woman cleaning or the word ‘clean’).

**Implications for the Industry**

Our research findings have far reaching implications for the field of communication. We have shown that the use of scent can indeed direct consumer attention towards a congruent pictorial, textual, colour or secondary-meaning stimuli. As such, we propose four ways in which this finding can be utilized in the advertising world and beyond.

*Breaking through ad clutter.* We have previously identified ad clutter as a problem that marketers increasingly face in this era of commercialization. By applying our findings, however, marketers will be able to tailor their ads with the appropriate congruent scent cues and advertorial cues, in order to direct attention away from competitor ads towards their own advertisements. As such, by influencing the gaze of consumers, advertisers will be better able to differentiate themselves from the ad clutter.

*Capitalizing on others’ scents.* In recent times, the number of businesses employing scent in their marketing mix is rising. As such, a new kind of ad clutter occurs, in which businesses compete for consumers’ olfactory attention. With the myriad of scents available in magazines in the form of rub-and-smell advertisements (Claburn, 2007) and scratch-and-sniff panels, marketers can make use of our research findings, to capitalize on existing scents in a magazine, rather than to compete with them. For example, if a prominent perfume company were to buy a citrus smelling rub-and-sniff ad in a magazine, marketers can choose to tailor their ads with elements congruent to the citrus smell, so as to visually direct the consumer’s gaze towards their advertisement as well.
New Scent Marketing Technologies. Although our research focused on examining the effect of scent congruency on print advertisements, our study is applicable even to other forms of advertising due to the advent of new scent marketing technologies (Kharif, 2005). Digitally enabled scenting is on the forefront of scent marketing innovation (Brumfield, Goldney & Gunning, 2008), and it allows consumers to smell what they visually perceive in digital form (e.g. smelling a product that is sold online, or smelling a scent from a movie). With the introduction of digital scent emitters such as the smell canon, scent dome, smell-o-vision and scented cartridges, scent can now be applied to non-traditional areas of advertising (e.g. in retail stores, online or in cinemas), to capture the attention of consumers. As such, this increases the advertising mediums with which our study’s findings can be applied to, and hence offers marketers new advertising options to employ scent.

Wider implications beyond advertising. Moreover, our research can also be applicable to essentially any business or industry, which may need to influence visual attention as part of their business. For example, amusement parks can use ambient scents to direct visual attention towards signages, so as to aid in the direction seeking process of park goers. In addition, restaurants can similarly employ ambient scents to direct customers’ visual attention towards certain promotions on their menus. Also, in large cities where dozens of competing restaurants line the streets, restaurant owners can employ the concept of scent congruency to direct the customers’ attention to their stores. As such, the implication of our research is not just confined to the realm of advertising, but can be utilized in various other forms of communication too.

Implications for Scent Research

In light of the lack in studies investigating the effects of olfactory cues on visual performance, we believe that our study on scent and visual attention serves to bridge this gap.
Moreover, our study also contributes to literature on the effects of scent on attention. We previously mentioned that most scent-attention studies operationalize attention as the amount of time spent evaluating a stimulus. However, our study adds a new perspective to this by operationalizing attention as the duration and frequency with which a specific part of a stimulus is fixated upon.

**Limitations and Future Research**

Due to the extremely time-intensive nature of operating an eye-tracking system, all three studies were conducted concurrently during a single experimental session. Test ads for each study concurrently served as dummy advertisements for other studies. We acknowledge that such an arrangement could have led to fatigue among subjects as well as an increase in the likelihood of spillover effects between experiments. However, to address the concern of spillover effects, care was taken to ensure that the order of the ads (and hence the order of the studies) were randomized. In view of this disadvantage, these three studies can perhaps be carried out in the future in individual experiments so as to examine the effects of scent and congruency on visual attention with greater accuracy.

Another limitation of this study was that all participants were under the age of 25 and that the majority of them were females. According to Bone and Ellen (1999), individual characteristics of subjects may be potential moderators of results. Moreover, scent is often considered to be culture-specific because the meanings and associations of a particular scent vary from person to person (Ackerman & Tellis, 2001). Further research can thus investigate the use of other moderator variables in their interactions with scent. For instance, the sample can be expanded to include other ethnic groups such as Caucasians, thereby enabling us to examine the different effects which may surface between varying cultures. Another possible
area of research would be to recruit participants from other age groups (such as the elderly) or to examine the effect of scent on different genders.

Further studies can perhaps also be developed in the area of visual attention and recall. Johnson & Proctor (2004) proposed a relationship between the two concepts, suggesting that paying attention to certain aspects of a scene can cause one to remember information more effectively and hence improve recall. Having established a link between visual attention and scent and congruency in our study, future research can perhaps examine the possibility of visual attention serving as a mediating variable between scent, congruency and recall.

Through this study, we discovered that the presence of a scent indeed improves visual attention towards congruent stimuli. Our research showed that this effect is not only confined to directly congruent stimuli, but also stimuli that share an indirect relationship with the scent (e.g. through colors and secondary-meaning congruency). We hope the findings of our study will open new avenues for advertisers and marketers to overcome the ever-increasing challenges of ad clutter. We also believe that this study will be a pertinent subject of interest to researchers and other industry practitioners due to its wide-ranging applicability to the world beyond advertising.
References


### Appendix A

**Scent Pretest: Mean Scores**

<table>
<thead>
<tr>
<th>Scent</th>
<th>Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lemon A</td>
<td>2.357</td>
</tr>
<tr>
<td>Lemon B</td>
<td>4.071</td>
</tr>
<tr>
<td>Lemon C</td>
<td>2.571</td>
</tr>
<tr>
<td>Mint A</td>
<td>2.142</td>
</tr>
<tr>
<td>Mint B</td>
<td>1.633</td>
</tr>
<tr>
<td>Mint C</td>
<td>3.928</td>
</tr>
<tr>
<td>Strawberry A</td>
<td>1.642</td>
</tr>
<tr>
<td>Strawberry B</td>
<td>3.857</td>
</tr>
<tr>
<td>Strawberry C</td>
<td>1.928</td>
</tr>
<tr>
<td>Citrus A</td>
<td>4.214</td>
</tr>
<tr>
<td>Citrus B</td>
<td>2.000</td>
</tr>
<tr>
<td>Citrus C</td>
<td>1.571</td>
</tr>
</tbody>
</table>
Appendix B

Fig 1a: Study One: Print Advertisement (Pictorial) – Congruent Cue

100% Fresh.

Fig 1b: Study One: Print Advertisement (Pictorial) – Incongruent Cue

100% Fresh.
Appendix B

Fig 2a: Study One: Print Advertisement (Textual) – Congruent Cue

Beat the morning blues.

Lady Love
CARE PRODUCTS™

Fig 1a: Study One: Print Advertisement (Textual) – Incongruent Cue

Beat the morning blues.

Lady Love
CARE PRODUCTS™
Appendix B

Fig 3a: Study Two: Print Advertisement (Color) – Congruent Cue

Fig 3a: Study Two: Print Advertisement (Color) – Incongruent Cue
Appendix B

Fig 4a: Study Three: Print Advertisement (Pictorial) – Congruent Cue

Fig 4b: Study Three: Print Advertisement (Pictorial) – Incongruent Cue
Appendix B

Fig 5a: Study Three: Print Advertisement (Textual) – Congruent Cue

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Write.
Read.

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Fig 5b: Study Three: Print Advertisement (Textual) – Incongruent Cue

Walk.
Work.
Write.
Read.

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Call 414-571-3566 or visit usatkd.com for details