Cultural Differences in Scene Perception

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Abstract

Do individuals from different cultures perceive scenes differently? Does culture have an influence on visual attention processes? This thesis investigates not only what these influences are, and how they affect eye movements, but also examines some of the proposed mechanisms that underlie the cultural influence in scene perception. Experiments 1 & 2 showed that Saudi participants directed a higher number of fixations to the background of images, in comparison to the British participants. British participants were also more affected by background changes, an indication of their tendency to bind the focal objects to their contexts. Experiments 3 & 4 revealed a higher overall number of fixations for Saudi participants, along with longer search times. The intra-group comparisons of scanpaths for Saudi participants revealed less similarity than within the British group, demonstrating a greater heterogeneity of search behaviour within the Saudi group. These findings could indicate that the British participants have the advantage of being more able to direct attention towards the goals of the task. The mechanisms that have been proposed for cultural differences in visual attention are due to particular thinking styles that emerge from the prevailing culture: analytic thinking (common in individualistic cultures) promotes attention to detail and a focus on the most important part of a scene, whereas holistic thinking (common in collectivist cultures) promotes attention to the global structure of a scene and the relationship between its parts. Priming methodology was used in Experiments 5, 6 & 7 to cue these factors, although it did not reveal any significant effects on eye movement behaviours or on accuracy at recognition of objects. By testing these explanations directly (Experiment 8), findings have mainly suggested the holistic-analytic dimension is one of the main mechanisms

underlying cultural diversity in scene perception. Taken together, these experiments conclude that the allocation of visual attention is also influenced by an individual's culture.

* Experiment 3 was presented as a poster at the 18th ECEM Conference held in the University of Vienna. An abstract of it was published in the *Journal of Eye Movement Research* under the title of "Cultural Differences in Visual Attention", page 271.

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Chapter 1: Introduction

1.1 Overview

This thesis is mainly concerned with whether an individual's culture can influence the allocation of visual attention when inspecting the world around them. A considerable number of studies in this area have shown that the East Asian participants had spread out their visual attention to an entire visual scene, when compared to the Western participants. Using participants from Britain as a Western culture and from Saudi that belong to Arab culture, which is considered to have unique characters even though it shares some similarities to the East Asian culture, the findings of the experiments conducted in this thesis displayed that visual attention differs, to some extent, due to the cultural factor. However, eye movement behaviours revealed that these differences tended to be more pronounced with some eye movement measures, and also, in some visual attention tasks. This thesis also attempts to clarify the cultural differences in scene perception takes place, where, a good explanation that has been repeatedly proposed in literature is that some cultures encourage holistic thinking styles, which fit in well with their values, social norms, and structures, while other cultures encourage analytical thinking strategies. These two thinking styles are essentially reflected through their visual attention, by either spreading out attention over the whole scene, or focusing on the most important part of it.

In the current chapter, I will begin by introducing the concept of scene perception, and the guidance of allocation visual attention in scene perception, and then the thesis will attempt to explain the role of culture in scene perception, with an overview of the key research in this area, and the main mechanisms that might underline cultural differences.

1.2 Scene Perception

It is no exaggeration to claim that our life is mainly constructed of visual scenes, and no matter where we are, we always surrounded by scenes. Most of these scenes, if not all, are complex, and involve plenty of information that exceeds our capacity to process them all at once. Visual attention when used in relation to perception can be defined as “preferential processing of some items to the detriment of others” (Findlay & Gilchrist, 2003, p. 3). This selection can be driven by bottom-up features of the stimuli and by a top-down guidance, which will be discussed later in this chapter. Attention can be described as *overt*, or *covert*, the first term used when we measure attention by eye movements, while the later means attention without looking. As Findlay & Gilchrist (2003) claimed that while the occurrence of covert attention is possible, it has a minor role in understanding visual attention, and on the other hand, overt attention, based on some basic facts about the structure of visual system plays a major role in understanding this process. For that, when we used visual attention throughout this thesis we mean overt attention, or in other words attending through eye movement behaviours, which will be discussed in detail later in the current chapter.

Scene perception is a complex activity, involving visual processing and cognition. It can be defined as ‘the visual perception of an environment as viewed by an observer at any given time, it includes not only the perception of individual objects, but also such things as their relative locations, and expectations about what other kinds of objects might be encountered’ (Rensink, 2000, p. 151). The concept of the scene is typically defined as a semantically coherent view of a real-world environment, comprising of background elements and multiple discrete objects (Henderson & Hollingworth, 1999; Findlay & Gilchrist, 2003).

It can be claimed, that the way we visually perceive our surrounding environment is, in general, an important means to shape our understanding of the world, as well as how we interact with it, and with one another, in different contexts. Investigating factors that are believed to influence scene perception is crucial in understanding mind and brain.

Visual attention is guided by the scene's own features, as well as the purpose of the task at hand, past knowledge and experiences, which leave room for predicting that the surrounding culture should ideally play a considerable role on this cognitive process. In the next section, bottom-up and top-down attention mechanisms will be reviewed, in order to illustrate some basic information about the way attention can be guided, before moving on to the concerns of this thesis, which is the possible influence of culture on scene perception.

1.2.1 Bottom-up/Top-down attention guidance.

What determines the allocation of visual attention, and what controls the shifts in attention, from one region to another? There are two general mechanisms, in which an individual's attention might be guided to a particular region or a target: bottom-up, or "stimulus-driven", and top-down, or "goal-driven" attention. Treisman & Glade (1980) described the bottom-up mechanism as an automatic detection for salient or novel stimuli, such as the differences in color, size, orientation and the direction of motion. The salient regions of a scene are expected to attract visual attention, based on their visual features, that differentiate them from their surroundings, as noted from the differences found in color, luminesce, and intensity. Real-world examples of bottom-up attention are seen when a bright flash, or a strong color, might capture your attention involuntarily. Investigating this mechanism has led to creation of computational models of visual search, in order to predict eye movements, by detecting the salient parts of the stimuli, such as Itti and Koch's (1999) saliency map model. These models are essentially built to represent the functional components of the human visual system from the retina to the striate cortex, in a purely bottom-up attentional mechanism (Duchowski, 2007). The predicted sequences of eye fixations are based on the concept of a visual salience map that explains the shifts in attention, and accordingly, the respective eye movements that are directed toward the region with the highest salience, and then, it is inhibited, in order for the attention to be directed to the second most salient region. Mannan, Ruddock & Wooding (1996) have found that the visual features of stimuli, e.g., edge density, predict, to some extent, the position of the first few fixations. A number of other studies have shown that the placement of the first few fixations is influenced by the visual features of the stimuli (Mannan, Ruddock & Wooding, 1995; Henderson & Hollingworth, 1999).

Additionally, Parkhurst, Law, & Niebur (2002) conducted an experiment, in order to test the validity of the saliency map, using a range of real-world photographs, such as home interiors, natural landscapes, and city scenes. The location of the first fixation was highly predicted by the stimulus feature's salience region, and for the remaining period of presentation, the location of fixations supported the bottom-up attention.

The salient regions of a scene are expected to attract initially visual attention, however, a top-down influence, which describes the voluntary intent to pay attention to a particular region, replaces the bottom-up guidance of attention, after the initial few fixations. Top-down attention means selectively attending to the task relevant stimuli, and inhibiting the task-irrelevant stimuli, which is controlled by the cognitive system that involves "self-monitoring mechanisms," ensuring that the task goal is being achieved (Luks, et al., 2002, p. 792). Early evidence for this attention can be found in Yarbus's famous book entitled, *Eye Movements and Vision* (1967). In early chapters a description of suction caps design was provided, the method he created to study visual perception of stabilized retinal images that also record eye positions when inspecting stimuli, and in the last chapter of that book he discussed the findings of his study on the *Unexpected Visitor* painting. Each participant viewed that painting seven times, each time with a different instruction, such as to remember the position of people, or objects in that scene, or to give some judgments, for example estimating the ages of the people in the painting, or simply free looking. These instructions showed a profound effect on the distribution of the eye movements in correspondence to them. Recent studies have investigated the influence of the semantic information of stimuli on the position of eye movements; for example, Neider & Zelinksy (2006) conducted an experiment, where they asked the participants to find targets that were typically constrained to certain parts of the scene, such as a jeep on the ground, or a blimp in the sky. They found that in target present condition, fixations were mainly limited to the area that one would expect to find the target, like "the ground or the sky," with 19% faster response; whereas, in the target-absent condition, the participants were less restricted in their search at the specific area. Underwood, Foulsham, & Humphrey (2009), in two experiments, tested the ability for saliency map model to predict the sequence of eye fixations, by comparing its sequence to those that were initiated by the actual participants, who performed encoding and recognition tasks, and they found that the fixation scanpath that was produced by the saliency map model did not predict the temporal order of fixations on neither the encoding, nor the recognition tasks. On the other hand, they found that past experience measured by the domain knowledge of participants; whether it is American Studies, or Engineering, seems to have some influence on inspecting photographs and recognising the previously seen ones, as in the American Studies students, they had similar scanpaths for the all three types of stimuli, and the Engineering students also showed the same scanpath with all three types of photographs that had different contents. Another study, conducted by Leber & Egeth (2006) supported the influence of past experience on the visual attention, as training on a specific search strategy, "one of two types of searching tasks; where the participants either searched for a specific color (red) among colorful distractors, or searched for a uniquely colored target among grey distractor objects," led the participants to adopt that strategy in the task afterward, regardless of the search type used in that task. But, what if the effect of the individual's past knowledge and experience is more general than the domain of study, or the training session? This is a point at which one's culture might affect the allocation of attention to different features of the image; this topic will be discussed in detail later in the current chapter.

To sum up, the information used to guide eye movements in scenes is believed to be guided in a bottom-up manner by both the basic visual saliency of the particular regions, and also by the application of top-down knowledge, as an early inspection of the visual stimuli is likely to be affected by certain conspicuous regions, and after grasping the meaning of the scene, the task-relevant regions are likely to capture attention. It is worth noting that all the reported studies here have used eye movement measures as an indication of visual attention mechanisms. This is logical, as eye movements are good, explicit means to understand this process, especially when it is acknowledged that people in real situations tend to move their eyes when shifting their attention, unless they are instructed otherwise. The next section will deal with the links between eye movements and visual attention.

1.2.2 Scene perception and eye movements.

At any one moment, our processing of visual information is limited to the small portion of the environment that is projected on the fovea, corresponding to two degrees of visual angle of the current gaze. Foveal vision represents acuity at its highest, but then, acuity falls off progressively to the periphery of retina (Duchowski, 2007), and thus, the highest quality of visual information depends on moving the eyes to re-position the new regions to adjust the foveal vision. Findlay & Gilchrist (2003) presented a framework that emphasizes the importance of eye movements to understand visual attention, as the mobility of eyes seems to be the only mean to combine high resolution with the ability to inspect the whole visual environment. According to Henderson & Hollingworth (1999), a complete understanding of the scene perception requires understanding the control over the fixation position during scene viewing, and how long that fixation tends to remain centred at a particular region, as they are online measurements of visual attention and its shifts. For the purpose of the current thesis, I will only focus on eye movement behaviour that is related to high-level scene perception, which reveals a number of different patterns in the previous scene perception research across the cultures.

Fixation and saccadic eye movements are believed to provide strong evidence of localization of overt visual attention, as the fixations are generally to indicate the desire to maintain the gaze on the area of interest, and saccades correspond to the desire to shift the focus of attention to another area of interest (Duchowski, 2007).

One of the earliest studies showed this correlation is a study conducted by Buswell (1935), as he found that the positions of fixations tended to be more frequent on the informative parts of the pictures that were viewed, as for example, the participants fixated people in the pictures, rather than in the background region. Another study found that the participants concentrated more on the informative regions of the paintings that they were instructed to view, in particular, the regions that most likely served the purpose of the viewing; such as fixating on the faces of the people in the painting, if the task was to estimate their ages, and had more distributed fixations when they were asked to find out the relationships between the people in the painting (Yarbus, 1967). Another study found that the informative regions of the stimuli were fixated more in a preference task (Mackworth & Morandi, 1967). This main finding has been replicated in a number of other studies (for extensive review see: Henderson & Hollingworth, 1999).

A fixation occurs when the eye gaze is directed at a particular scene, and it is thought to represent the moment when the eyes are encoding information. On average, a fixation lasts for about 218 milliseconds (Poole & Ball, 2005). Fixations directly reflect the allocation of attention: a higher number of fixations in a specific area, indicate that this area is more important, or more informative to the viewer (Chua, Boland, & Nisbett, 2005; Goldberg & Kotval, 1999; Itti & Koch, 1999; Poole & Ball, 2005; Poole, et al., 2004; & Duchowski, 2007). One important note about the interpretation of the number of fixations in a particular region is that it depends highly upon the task goal, where, if the task is, for example, encoding, then the higher number of fixation can be a reflection of a greater interest in that region (Jacob & Karn, 2003; Poole & Ball, 2005). However, in the case of a search task, which will be discussed in detail in Chapter 4, the higher number of fixations could be an indication of greater difficulty in recognizing the target (Goldberg & Kotval, 1999; Jacob & Karn, 2003). Fixation durations vary, and they are also task-dependent. For example, the mean fixation duration on a reading task is 225 ms, while at scene perception; it is 330 ms (Rayner, 1998). Although there is no agreement on the minimum or maximum fixation duration, Duchowski claimed that the fixation duration varies from 150 ms to 600 ms (2007). In the field of visual attention, it is demonstrated that the duration of fixations is affected by the nature of the visual information available in the fixated area and its density (Henderson & Hollingworth, 1999; Rayner, 1998). For example, Mannan, Ruddock &Wooding (1995) found that fixation durations were shortest for the unfiltered versions of the scenes, and longest for the low-pass filtered scenes, supporting the influence of visual information available in the scene. Although that it is evident that durations of fixation are -on average- longer for an informative region of a scene, there are some other factors that could influence this measure such as the consistency of the object within the scene, as Underwood & Foulsham (2006) have found that longer fixations were found on the incongruent objects of the scenes. Other factors such as image type, exposure time of the scenes, and task type are also found to influence the duration of the average fixation (Henderson & Hollingworth, 1998).

To process information elsewhere in the scene, the eye must move. This is termed a saccade, and is a fast and rapid movement of the eye that brings one point of interest to the foveal region. The duration of saccadic movements vary from 10 ms to 100 ms (Duchowski, 2007). During a saccade, the perceptual input from the scene is suppressed (Rayner, 1998), which is likely due to the occurrence of motion blur during that movement. Thus, we cannot take saccadic movement to indicate regions of interest or most salient areas; however, the higher number of saccades could be linked to more search and inspection (Goldberg & Kotval, 1999; Poole & Ball, 2005). Finally, in the eye-tracking studies in general, one limitation should be acknowledged when using the eyes to indicate visual attention. This limitation stems from the fact that some parts of the visual scene that is not under fixation, seem to guide the location of the next fixation (Underwood & Everatt, 1992), which suggests that the region that is under fixation, is not the only region that is processed.

From what we have discussed so far, the utility of eye movement measures for understanding scene perception is clear, and that measures of fixation behaviour (i.e., the location, number, and duration of fixations) are indeed useful indices of the underlying processes. Although eye movements are thought to represent very similar visual-attentional processes across participants, they might in fact be subject to individual differences. Some of these differences might be in the basic task, but factors such as culture, which will be discussed in the next section, might have a more profound impact on scene inspection. For the purpose of this thesis, we will focus on the eye movements that show cultural differences on scene perception in previous researches, such as the number of fixations, duration of fixations, and, to some extent, saccades (e.g., Chua, Boland, & Nisbett, 2005).

1.3 Cultural Influence on Scene Perception

Firstly, one should answer the question of the reason for expecting culture, which will be defined later in this section, to influence visual perception, while it is known that every culture includes individuals with a wide variety of cognitive, emotional, and personality-based characteristics. As it has been stated earlier, visual attention is a cognitive process that determines the selection of some visual information in the surrounding environment to be processed, and what is to be neglected, and this selection is modified—among a number of factors—through cultural factors (Kitayama & Duffy, 2004). Hence, it is logical to assume that the individuals of one culture, who share social norms, beliefs, values, as well as political and economic situations, would show certain attention strategies over others. In the field of scene perception, cultural differences have been reflected in the attention allocated to the focal point that represent the most salient item of the scene, versus distributed attention between the focal point and the background of stimuli. Research that has investigated the cultural differences in this area have used eye movements obtained from eye-tracking techniques, as an appropriate tool to test the allocation of visual attention, to indicate the focused attention, "analytical" to the salient parts, versus the attention to the whole "holistic" (Miyamoto, 2013) as a mechanism underlying the cultural differences, this mechanism and the cultural factors that might influence the analytic/holistic tendencies will be discussed in detail later on. Thus, most of these studies have compared the eye movement behaviours of two different cultural groups by dividing the stimuli into two main areas, which are focal and background (e.g., Masuda & Nisbett, 2006; Miyamoto, Nisbett & Masuda, 2006), and most of them have concluded that visual processing does not seem to occur in a similar manner for everyone, as culture appears to have a role on visual attention, and accordingly, on eye movements. The final note here is the fact that the main aim of the current work is to capture the differences in scene perception at the cultural level, and not at the individual level, which is why the scores of all participants on all measurements in the current thesis were averaged for each cultural group.

Before proceeding with research into this issue, one should be aware of the fact that the role of culture remains a subject for debate, which is partly because of the relevant literature that includes a number of contradictory studies. Furthermore, it is yet to be clarified which aspects of culture could account for the differences in perception. Here, we will begin by reviewing some of the key studies conducted on this topic. We will then go on to discuss some of the underlying mechanisms that have been proposed as the possible causes of cultural differences with reference to scene perception.

1.3.1 Research into cultural differences in scene perception

It is necessary to define the term *culture*, before highlighting the main work conducted in this area. Hofstede (2001) defined culture as “the collective programming of the mind that distinguishes the members of one group or category of people from another” (p. 9). Kitayama, Duffy, & Uchida (2010) noted that many definitions describe culture as "a whole set of symbolic resources of a given community" (p. 138). Those symbolic resources are derived from the history of a community, and are thus reflected in its social practices and institutions. Cultural ideas and practices are open to change over time, both within and across generations, and, as they have multiple meanings, they can be manipulated and interpreted differently by different individuals within the society (Kitayama, Duffy, & Uchida, 2010). According to Wang & Ross (2011), culture is ‘both a system (values, schemas, scripts, models, metaphors, and artefacts), and a process (rituals, daily routines, and practices) of symbolic mediation […] operating on social institutions […] as well as on the actions, thoughts, emotions, and moral values of individuals’ (p. 646).

Cross-cultural studies of perception have revealed numerous examples of cultural diversity, even for relatively simple visual stimuli. A classic study conducted on the Muller-Lyer illusion, for example, found that Westerners tend to be more susceptible to this illusion than non-Westerners (Toch & Smith, 1968). Another study examined attention to the context versus focused attention, which are the mainly proposed mechanisms underlying cultural diversity on scene perception, using a relative versus absolute judgment task, consisted of a series of vertical lines, each of which appeared in a square frame. The task was to reproduce the line, either in the same "absolute" size of the original square, or in proportion to the dimensions of a square with different size than the original one "relative", and it was found that the Japanese were more accurate in the relative task, while Americans were more accurate in the absolute task, which indicate that Japanese paid more attention to the lines in relation to the context, while the Americans did focus more on the lines themselves. Interestingly, when the students spent a year in the other culture, they tended to show an improvement in performing the task, which related to that culture (Kitayama, et al., 2003). This demonstrated the way exposure to a different culture can alter the performance of an individual, and may influence them in other, less obvious ways. Another note here is that the focus in differentiation between the cultures is essentially based on the differences in holistic/analytic thinking style (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; McKene, et al. 2010).

Many scholars have conducted studies supporting the notion of cultural variation in scene perception, and this was tested by calculating eye movements in focal or central area of interest, that represented the most salient object, and the background, with an expectation for the Westerners to show focused attention on to the focal area, and the Easterners to show more spread of attention. Masuda & Nisbett (2001) examined whether Japanese and Americans differed in their patterns of attention to the background. In the first task, the participants were shown animated vignettes, featuring underwater scenes. They were asked to describe the content of the vignettes, and then, to complete a recognition task, consisting of some repeated and some new objects, against either familiar, or new backgrounds. The participants were then asked to judge whether they had seen each object during the first inspection. Findings indicated that the Easterners offered more detailed statements about the background than the Americans, while the Westerners tended to begin their descriptions by referring to the most salient objects. Easterners, on the other hand, were much more likely to begin by making a reference to the context. In the recognition phase, the Easterners' scores were higher for the objects presented in their original backgrounds. In another study, the Americans appeared to fixate more on focal objects than the Chinese, and tended to look at them more quickly, while in the recognition phase, the Chinese participants were less likely to recognize familiar objects, when they were presented in new backgrounds (Chua, Boland, & Nisbett, 2005). These findings were explained by the differences in the analytic/holistic cognitive style, with a note that Nisbett and his colleagues defined holistic system of thought as "involving an orientation to the context or field as a whole, including attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships," and the analytic system of thought as "involving detachment of the object from its context, a tendency to focus on attributes of the object to assign it to categories, and a preference for using rules about the categories to explain and predict the object's behaviour. Inferences rest in part on the practice of decontextualizing structure from content, the use of formal logic, and avoidance of contradiction," (Masuda & Nisbett, 2001, p. 293). Goh, Tan & Park (2009), in their study, aimed to investigate whether the stimulus changes that direct the eye movements toward specific elements in scenes overrode the top-down cultural process. The study found that the American participants had longer durations of object fixation; furthermore, the number of object fixations decreased, as objects were repeated, but, if a new object was presented, the number of fixations on it increased. This was not the case with the Singaporean participants, whose number of object fixations decreased over time, regardless of the object conditions. Another finding of this study was that the Singaporean participants had a greater proportion of saccadic movements between the objects and backgrounds than the US participants. These movements may indicate that the Singaporean participants were attending to the objects on their contexts, in other words, their attentional style was more contextual, or holistic.

These findings have been replicated in a number of studies (e.g., Kitayama, et al., 2003; Nisbett & Miyamoto, 2005). However, we should not neglect to mention that a small number of studies have failed to find the cultural differences in scene perception. Rayner et al. (2007), for instance, compared eye movement behaviours for U.S. and Chinese participants in six different tasks, including scene perception. The task was to inspect the pictures in preparation for a memory test, and no significant differences were found between the groups on the duration of fixations. However, this result could be due to the nature of the pictures used, which consisted of multiple focal objects on an almost empty background. Boland et al. (2008), in their reply to Rayner et al. (2007), emphasized upon the importance of using pictures, which consisted of one foreground object against a rich background. Additionally, their task was performed with other tasks, and only the duration of fixations in the whole photograph was measured. More recently, Evans, Rotello & Rayner (2009) made use of the original scenes that had been used by Chua et al. (2005), and they added more scenes to increase the statistical power, and also, did not find any significant differences between the two cultural groups in the eye movement measures.

The question of whether the cultural differences exist in scene perception therefore remains unresolved, and the inconsistencies in the current findings suggest that more research is needed. It is important to note that the majority of research in this field, which found cross-cultural differences, interpreted their results mainly by the differences in analytic/ holistic cognitive processing, and only a small number of these studies provided a direct test to their claim, as a small number of these studies have directly tested their analytic/holistic assumption, and others have used priming methods, which will be discussed in detail in Chapter 5, to facilitate the access to these concepts and test their effect on the visual attention. Below is an overview of the main mechanisms that have been proposed for cultural differences in scene perception.

1.3.2 Culture and societal effects.

The type of relationship between an individual and the members of his/her group seems to vary across cultures. One framework for understanding these differences is by measuring the individualism-collectivism continuum, which has been extensively studied in a number of disciplines (e.g., Messervy, Jun & Uchida, 2004; Oyserman, Coon & Kemmelmeier, 2002). Based on this framework, individualistic cultures tend to emphasize personal goals, and encourage the desire to be different, whereas collectivistic cultures emphasize the priority of group goals, and value obligations (Hofstede, 2001). A number of individualism/collectivism cross-cultural studies have supported a distinction made between the Western cultures and East Asian cultures, where the Western cultures are seen to be more individualistic, whereas the East Asian cultures are seen as more collectivistic (Chiu, 1972; Nisbett, et al., 2001; Varnum, et al., 2010). Studies conducted on the Middle Eastern cultures have concluded that they tend to be more collectivist (Shakibai, 2005).

The individualism-collectivism dimension was described as "cultural syndromes … Reflect shared attitudes, beliefs, categorizations, norms, roles, and values organized around a central theme, that are found among individuals who speak a particular language, and live in a specific geographic region, during a specific historical period" (Triandis, et al., 1995, p. 462). Looking at this definition, one can rightly assume that the definition of this dimension has a number of aspects that correlate to each other, such as attitude, beliefs, and norms, which need to be unpacked, in order to achieve a better chance to accurately measure it. Throughout this thesis, our focus is on two specific aspects that relate to this dimension, which are reflection on cognitive processing and on self-image. Both concepts have been repeatedly proposed to underlie the cultural differences in scene perception (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Kühnen & Oyserman, 2002).

The individualism-collectivism dimension is, thus, reflected by the preferred cognitive styles, as the characteristics and social practices relate to each ends of this continuum influence cognitive development, resulting in the adaptation of independent (analytic)/interdependent (holistic) cognitive styles that, in turn, shape the way the person responds to his/her environment (Witkin & Asch, 1984). A number of cross-cultural studies showed that the Easterners (who generally classified as collectivistic cultures) exhibited a greater holistic style, and, on the other hand, the Westerners (who generally classified as individualistic cultures) showed a greater analytic style measured by a variety of tasks that mainly required some identification or distinguishing hidden or local shapes from the surroundings such as embedded figure (EFT), and Navon tasks (e.g., Kühnen, Hannover &Schubert, 2001; McKene, et al. 2010), or simply by using patterns of fixations, "fixations to focal area versus fixation to the hole," as prediction of these thinking styles (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Jenkins, et al., 2010).

Tracking the concept of holistic-analytic dimension, one would find that it is a distinction inherited from the notion of *field dependence/independence* (Masuda & Nisbett, 2001). It is generally defined as "an individual's preference for processing information either in complete wholes or in discrete parts" (Davies & Graff, 2006, p. 990). According to Norenzayan, Choi, & Peng (2010), processing information holistically means that the "attention to relationships between a focal object and the field, and a preference for explaining and predicting events on the basis of such relationships" (p. 577), while an analytic style means a tendency to detach the object from its context, and use logic and rules to explain and predict it's behaviour. It should be stated here that these thinking styles have been described using different terms, and although we used *analytic/holistic* thinking styles most frequently in the current thesis, we also used the *local/global* terms, when appropriate. A final note concerning these two cognitive processes is that they are not different abilities, as people can use either of them, but a bias towards one of them is highly likely through sustained engagement in cultural practices that encourage one of them. Experiments with the prime method are a proof of the ability to switch between them when it is triggered.

The individualism/collectivism dimension creates an impact on the relationships with others, and the image of the self. *Independent-interdependent self-construal*, which will be discussed in Chapter 6, section 6.1, is basically a general mode of being that is likely to measure the individualism/collectivism continuum in individual level (Kam, et al., 2012; Parkes, Schneider, & Bochner, 1999), in other words it means the tendency to express the self in social situations by individualistic or collective aspects, by seeing the self as unique or as a member of a group. It is believed that this dimension mirrors the two aforementioned styles of processing information in a social context. Norenzayan, Choi, & Peng (2010) claimed that “an analytic mode of processing is more prevalent in Western cultures, where people are also more independent, whereas a holistic mode of processing is more prevalent in East Asian cultures, where people are also more interdependent” (p. 586). Furthermore, it is believed that the style of cognition (analytic vs. holistic) is one important element among others (action as influence or as adjustment and self/other centricities) to describe the differences between the two modes of being (Balcetis & Lassiter, 2010; Norenzayan, Choi, & Peng, 2010).

To measure the interpretation underlying cultural differences in the scene perception in the current thesis, we have used EFT and Navon tasks. As the focus in this thesis is to investigate the above discussed account for cultural differences in scene perception, independent-interdependent self-construal was also used to test whether the differences in analytic/holistic style is due to the differences in social practices of collectivism/individualism cultures. A description and suitable examples of these measures is provided in the related chapters. In the next section we will discuss the visual environmental explanation for cultural differences in visual attention.

1.3.3 Environmental effects.

A series of studies conducted by Davidoff and his colleagues (2008; 2012; 2013; &2015) proposed that the visual environment is responsible for the differences in cognitive process styles (global/local), measured mainly by Navon task. The more visually cluttered the environment, the wider visual attention is spread out, and a tendency to decrease the local thinking style is seen. The works of Davidoff and his colleagues were conducted on British participants and the Himba of Northern Namibia, who can be classified —in principle—as a collectivistic culture. The Himba society was structured around large families, and their social positions were allocated rather than achieved, where it can be noted that such society, in principle, promotes interdependent relationships and behaviours. Davidoff and his colleagues had earlier found a local advantage for the Himba group, when comparing their performance with the British group on the Navon-like task, which is basically a target shape (e.g., H), positioned at the top of the display, with two shapes below (e.g., H & S), positioned side by side, so that each of them shared one feature of the target shape; either at a local or at a global level. The British participants showed a tendency to choose the global shapes, and believe them to be more similar to the target, when compared to the Himba (Davidoff, Fonteneau, & Fagot, 2008). Based on this study, the differences in holistic/analytic styles are not a reflection of the differences in collectivism/individualism cultural dimension as in the previous account, but by the characteristics of visual environment those cultures inhabit.

Visual clutter environment proposal was further tested in a study, which was conducted by Carparos et al. (2012); to investigate the way exposure to an urban environment can lessen the local processing of visual information for the Himba participants. The subjects for this study were divided into four groups: British, Japanese, traditional Himba, and urbanized Himba. The results showed that the British and Japanese participants had a similar percentage of global selection, urbanized Himba made more global selection than the traditional Himba, and more importantly, only two visits to the nearest urban city for traditional Himba increased their global choice by up to 10%, which emphasized on the ability for creating changing on visual environment, in order to alter the processing of visual information. This study again emphasizes the role of visual environment on cognitive processes rather than cultural practices.

In another Navon-like task that required detecting the global target and ignoring local distractors "inconsistent shape, such as a global square made up of local crosses," or doing the opposite, detecting the local target and ignoring the global distractor. The Himba participants were expected, based on the previous work, to be more distracted by the local distractions in global selection targets, when compared to the British group. However, they took a considerably shorter time to accurately detect the local and global targets, which suggested the greater capacity for them to concentrate on the task at hand (Carparos, et al., 2013), which possibly indicate the extraordinary capacity for them to concentrate on the task requirements. A recent study, conducted by Linnell, Carparos, & Davidoff (2014), was aimed to investigate the mechanism underlying that higher concentration capacity on the task. They proposed that the urbanized people, due to the dynamic and unpredictable environments, developed high levels of "intrinsic alertness"[1], which meant, in simple words, a high sensitivity to the external stimulation that lead, in turn, to explore the world in a way as to interact with it, while the remote people had "middling alertness," which means that they had a lower sensitivity to the external stimuli, that leads to task engagement, as a way to interact with the world. To test the different levels of intrinsic alertness,[*] they tested the left-right spatial biases, as it has shown previously that the change in intrinsic alertness levels may affect relative hemispheric

[1] We described *intrinsic-alertness* as internally controlled wakefulness or arousal.

activation patterns, specifically, decreasing the intrinsic alertness leads to a rightwards moving spatial bias, while increasing it can lead to a leftwards moving spatial bias. Based on that, they predicted that Himba participants would show rightwards bias. In a line-bisection task that consisted of horizontal lines, each of which was bisected by a small vertical line, located on one of seven possible locations on the middle, left, or right, participants were to decide which part of the horizontal line was longer, using two alternative forced choice: right button and left. The Himba participants showed a reduced leftwards bias when compared to British group, which basically supported the "different levels of intrinsic alertness" hypothesis, as this reduction in leftward bias was positively correlated with lower sensitivity to the external stimuli, which explain why Himba group can concentrate more on the task at hand.

Although the proposition of the physical environment's influence has recently attracted attention, it has previously been discussed many years ago. Goldenweiser (1916) suggested a cooperative relationship between culture and environment, with an emphasis on the independency of culture as a dynamic aspect with the historical complex of its environment, which can be described as static. Additionally, it can be noted that the visual environment proposal has some agreement with Berry's (1991) eco-cultural framework, where he found that the less structured societies (e.g., hunters) showed a tendency to be more field-independent. Nevertheless, some researchers, Berry included, explained the differences in holistic/analytic thinking style between these environments through certain social practices. Witkin & Berry (1975) found that socializing and survival were the ways in which different environments required some form of adaptation of different cognitive and perceptual process, as, by using EFT, it was found that the hunters "who were from environment that require individual enterprise," were faster in finding the shapes, when compared to the West Africans, who were raised in environment that required interdependent roles and collective actions.

Until there is strong evidence of other alternative explanations for certain cultural differences, in cognition and scene perception in particular, we believe that the aforementioned mechanisms, the differences in social practices and their subsequent effects on the self and one's thinking styles, and the environmental visual clutter, are the most available interpretations that are empirically have some form of support. Although the environmental interpretation is very interesting and promising, the alternative cultural framework is still worth investigating and is not over yet—especially when testing it in other cultures that have their uniqueness, as they have slightly different prosperities, and are positioned differently in collectivism/individualism dimension, when compared to the Easterners or Westerners, which is the case of the Saudi culture. Arab, and the Saudi culture in particular, will be discussed in greater details in the next section.

Throughout this thesis, we will compare Western (British) and Middle Eastern (Saudi) participants in scene perception. The majority of the previous studies have been limited to make a comparison between the Westerners and the East Asians, and their tendencies to focus on the focal objects, or the background of visual stimulus. Research about cognition in the Arab culture is rare, especially the ones that are written in English language, most of which are now quite dated, and with many observations that are no longer applicable. The next section intends to shed some light on the main features of Arab, especially the Saudi culture, which could shed some light on the expected differences in scene perception.

1.3.4 Saudi culture.

Arab is a general word, which embodies and represents 22 countries in the Middle East region. These countries share a huge deal in common, such as the Arabic language, and some basic Arabic traditions; and yet, they have some subtle differences, like, for example, some of those countries can be seen as more heterogeneous than others, for example, in Lebanon, about half the population are Christians while almost all population in Saudi Arabia are Muslims with Sunni Islam as a majority (Central Intelligence Agency, 2014).

The majority of the previous studies investigated cultural differences in scene perception merely compared the Westerners with East Asians, in their tendencies to focus on the focal objects, or the background of visual stimulus. To the best of our knowledge, only one study was conducted in the Middle Eastern region, as it investigated the differences in the number of saccades, from left to right, and from right to left, between three cultural groups—Westerners, East Asians, and Middle Eastern people—which have three different reading and writing strategies, and found that the Middle Easterners had the higher number of saccades from right to left, when compared with the other groups (Abed, 1991). The lack of research on scene perception in Saudi Arabia and in the Middle East, in general, is an important reason for research being needed in this area considering the fact that Arab culture differs than the Western and East Asians cultures on a number of factors that could affect visual attention in a certain way, such as the religious beliefs and practices, and the characteristics of their language. These factors will be discussed in detail later in this section.

In spite of the lack of good data in this particular field, one may have some expectation of the way the people from Arab culture would inspect visual scenes, which is based on the research carried out on the aforementioned possible explanation for cultural differences in scene perception, as being more collectivistic, or individualistic. In terms of collectivistic-individualist dimension and its related aspects, Hofstede performed a study on more than 60,000 IBM workers from various ethnicities, that differentiated various cultures, based on a number of cultural dimensions, which included power distance (PDI), individualism vs. collectivism (IDV), masculinity vs. femininity (MAS), uncertainty avoidance (UAI), and long-term vs. short-term orientation (LTO). Individualism in IDV is related to societal attachment to individual attention to themselves and their families. Collectivism in IDV, on the other hand, relates to the protective loyalty to cohesive group membership that lasts through an individual's life span, since birth.

In relation to individualism vs. collectivism dimension, Western culture was 60% more focused on individualism than the Arab countries, which heavily related to collectivism (Hofstede, 2001). Arabs also did not tend to work independently, and highly valued teamwork, emphasizing the control on not standing out from anyone else in the group. Relationship was more important to them than the assertiveness that was valued by the Westerners. Arabs also held high regards for those in authority, and were also less likely to pursue risk. Tradition, in general, was more important to Arab culture. Sagy, Orr, Bar-On, & Awwad (2001) found that both Israeli-Jewish and Palestinian-Arab groups—who are both parts of the Middle Eastern region, tended to be more collectivistic, with the Palestinians scoring higher than the Israeli group on the items such as measuring and emphasizing an in-group collectivistic orientation (e.g., my nationality). In a recent study, 174 Saudi participants, from a number of Saudi universities, scored 27.72 on individualism vs. collectivism dimension, which was similar to the Hofstede score of Arab region "38". This means that individuals in Saudi Arabia tend to see themselves and act as members of groups more than standing out from the crowd (Alamri, Cristea, & Al-Zaidi, 2014). A tendency for the Arab culture to be classified as collectivistic is also found on other studies (e.g., Buda & Elkhouly, 1998).

The manner in which the individuals from Saudi Arabia and Britain, as two contrasting cultures, perceive the same information gathered on a visual scene, is most likely to be different, as aforementioned studies have indicated that Saudi and Arab participants tended to show more holistic style and see themselves in a more collectivistic manner when compared to the British. However, we cannot assume that all collectivist/individualistic societies necessarily operate in a similar manner when inspecting such visual scenes. Although these studies suggested that they might perform in a similar way to East Asians, the possibility, that they might be positioned somewhere different than the Easterners of the collectivism-individualism spectrum, is highly plausible. This possibility is more evident when considering two main points; first: only a small number of studies conducted in this area showed that the Arabs were classified as collectivistic, with a majority of them looking at the region as a whole, and overlooking its complexity, which needs to be considered with caution, as this region contains 22 countries, that do not necessarily share the exact degree of cultural aspects, such as a variety in religious practices and beliefs, education systems, and regional costumes. A study conducted by Buda & Elkhouly (1998) on American, Egyptian, and Gulf state samples have confirmed the differences in the Arab culture, as they were able to detect a significant difference between Egyptian and Gulf state participants, with the latter sample being more collective.

The second reason for expecting Arab regions—especially the Saudi region—to perform differently than other collectivistic cultures is related to the way collectivistic/individualistic values interact with other cultural factors. Values, self-image, and social practises, whether they tend to be more collectivist or individualist, are affected, and might be partly shaped by other cultural factors that are needed to be taken into consideration. Religion is, for certain, one of these factors, especially when Islam as a major faith in the Arab world is argued to play a vital role in that culture, which can be seen in many aspects of the economic and social life. Gellner & Charles (1972), by making comparisons between Islam, Christianity, Judaism, and other religions that exist in different cultures, argue, that Islam, in comparison to other religions, is more likely to affect social order, as it organized some social principles in rural and urban lives as well. Other scholars emphasized upon the importance of understanding the role of religion in Arab culture, in order to be able to understand their cognitive styles (Boorstin, 1992; Marulanda, 1996). It is worth noting here that recent research has suggested a vital role for religious beliefs on attention processing. Colzato, Wildenberg & Hommel (2008) found that the position toward religion lead to the adaptation of different perceptual strategies, even among the people of the same country. In their study, Calvinists showed a smaller global preference on Navon shapes, comparing to the Atheists. They attributed this result to the Calvinists belief that emphasizes on the independent view of the self and individual responsibility, but then, a question arises about the religious beliefs that might encourage social solidarity. To review the work conducted to test this issue, a paper was published recently in Intelligence (Colzato, et al., 2010), which distinguished between the religious believers, "Judaism/Catholicism," and non-believers, found that the latter ones showed a tendency toward analytic cognitive style in a number of measures, including self-reports, and performances.

Most people in the Arab world show a strong bond to their religions. The most prevalent religion in Saudi Arabia is Islam, and for the majority, it is Sunni Islam, with no organized hierarchy, or central authority. The impacts of religion in Saudi Arabia can be noticed in many aspects of life, such as the way the people raise their children, and in their treatment of parents and elderly people. In other words, all rules in Saudi society claim to be based on Islamic traditions. Islam shares some common features with Judaism and Catholicism, such as social solidarity, which may suggest that it will work on encouraging holistic cognitive style as the other two. However, a number of Quran verses, and Hadith (the two sources of the religion of Islam) have also encouraged individual responsibilities and creating the internal locus of control, which were previously linked with analytic thinking style (Colzato, et al., 2010). Additionally, one important aspect of the education system in Saudi Arabia is the encouragement to read and memorize the Holy Quran in schools, and this memorizing may encourage analytic thinking style, because each letter in every word has its own formatting symbol, and, if mistakenly changed, it can change the meaning of the whole verse, which emphasise upon the importance of attention to these details. It is worth noting here that the aforementioned note is a characteristic of classical Arabic language, as, for example, the differences in written Arabic language between these sentences and word: "He wrote", "it was written", and "books" is basically through these symbols "كَتب كُتِب، كُتُب،", where the attention is given to micro-level details in the written Arabic language, which, in general, may encourage analytic cognitive style as well. The findings of the experiments in this thesis are expected to offer more insight into the ways in which inspecting visual world and searching strategies are modified by the culture, and thereby bring about a deeper knowledge of the importance of culture in understanding cognition.

To sum up, the lack of research on scene perception in Saudi Arabia, and in the Arab countries, located in the Middle East, in general, is an important reason for research being needed in this area especially when taking into account that although Arab culture tended to be described as collectivistic, it has on the other hand some important different aspects that may change the way they inspect the world surrounding them. Saudi participants, raised in a religious cultural context, with emphasis on collectivistic values and practices, but with analytical learning strategy were expected to perform in a different way than the Western and Eastern cultural groups when inspecting real world photographs. Moreover, the size of this different ways of inspecting the scenes is expected to be more significant, when we compare their performance with their British counterparts, who, broadly, are raised in a secular context, with emphasis on individualist values and behaviours. Throughout this thesis, the prime aim is to compare the Westerners (British) with Saudi participants, using a number of different visual tasks, in order to find out whether there are significant differences in visual inspection and searching behaviours between individuals who were raised in these different cultures. Conducting our experiments will not only add to our understanding of the cultural variation in visual perception but, to some extent, will add to understanding the human mind, and it will also have some important implications in the area of computational modelling of eye movements. Additionally, it could add a significant amount of valuable information to other areas of interest, such as advertisements, like, for example, in market research, one important aim is to understand the consumer actions, so, if culture influence the consumer attention, knowing how this factor is in play may help to promote the products in a way that is consistent with different contexts. International movie companies and art, in general, should also take culture into consideration when promoting a piece of art for popularity. A quick glimpse of movie posters created in different cultures would clarify the importance of this effect.

1.4 Outline of the Thesis

The current chapter reviewed the mechanisms of perceptual attention in scene perception, and the role of culture, in this process, with a discussion of the main mechanisms underlying the cultural differences. The current thesis consists of a series of experiments that are mainly to investigate cultural effect on scene perception, using a range of visual attention tasks.

Following a general description of the methods used throughout the experiments (Chapter 2), Chapter 3-6 describe the findings of eight experiments, with the aim to test cultural influence on scene perception. In Chapter 3, two experiments with two tasks, that are often used to investigate scene perception across Western versus Easter cultures, are performed to find out whether we can obtain similar findings while testing a culture, that, even though shares some similar features with Eastern cultures, has its unique characteristics. Two experiments in Chapter 4 attempt to answer the question whether cultural influence can be found in a goal-driven task, which has been mainly neglected in the relative literature, such as visual search. In Chapter 5, three experiments concentrate on examining the proposed mechanism that underlie the cultural effect in scene perception, which is basically the tendency to process information, either holistically or analytically. This is achieved by using a priming method to trigger local/global thinking, or independent/interdependent self-image, and tests the triggering effect on the subsequent scene perception tasks. A series of comprehensive visual cognitive tasks in Chapter 6 aims to explore other areas in visual attention that may reveal significant differences across cultures, which helps to understand the depth of this effect. This chapter also tests the previously mentioned explanation, by testing a number of measures directly on the British and

Saudi samples, with the Saudis purely representing their culture, as they have never visited the UK, or any other Western countries.

Chapter 2: General Methods

This chapter describes the common methods that have been used throughout this thesis; however, where methods differ they will be described in the relevant chapters. In investigating the differences between two groups from different cultures on scene perception, the majority of experiments involved the following factors.

2.1 Participants

Two groups of participants representing British and Saudi cultures were recruited in the experiments, with the exception of the priming experiments (5, 6, and 7). Sample size in most experiments conducted here was about 30 participants divided into the two cultural groups, this was based on the fact that it was difficult to find Saudi samples who only spent a year or less in Nottingham city for each experiment, bearing in mind that sample sizes in the related previous studies was about this number in each cultural group (e.g. Gutchess, et al., 2006; Kühnen & Oyserman, 2002; Kitayama, et al., 2003; Boduroglu, Shah & Nisbett, 2009; Miellet, et al., 2010; Lao, Viziol & Caldara, 2013). In the prime method experiments, all participants were British: half were randomly assigned to the collectivism prime group and the other half were assigned to the individualistic prime group. Most Saudi participants were students on English learning courses run by the Centre for English Language Education (CELE). Males and females contributed equally to the cultural groups for most experiments; other than that, the gender variable was not further considered in this thesis as it is out of our scope and due to the fact that some studies have not obtained gender differences in the tendency to global preference (e.g. Kimchi, Amishav, & Sulitzeanu-Kenan, 2009; Poirel, Pineau, Jobard, & Mellet, 2008). Additionally, in terms of independent/interdependent self, although females even in individualistic cultures tended to show more interdependent self, this tendency is taking a different form than that common in collectivistic cultures. For example, the obligation and scarification of her own goals are to achieve other goals related to her family and children, not because she is after her group satisfactions and approval (Fiske & Taylor, 2013). In all experiments, participants gave their consent to participate, with the knowledge that they were permitted to withdraw at any time.

Participants were recruited through the Research Participation Scheme (RPS) run by the School of Psychology, from posters in University buildings, and by email. British participants were given a choice between payments of an inconvenience allowance to take part, or earning course credit points from RPS. However, Saudi participants were only paid an inconvenience allowance ranging from £3–5.

2.1.1 Common constraints on recruiting participants.

All participants had normal, or corrected-to-normal vision, and when a specific rate of missing data was detected (25%), that participant was replaced. Saudi participants had not lived in the United Kingdom or any other Western country for more than one year, except for Experiment 1, in which some participants had spent two years in the United Kingdom. British participants were born and raised in the UK and were native English language speakers.

2.2 Stimuli

The main aim of all experiments conducted in the current work was to compare eye movement behaviours between Saudi and British groups, with a particular focus on fixations within the focal and background areas of visual scenes. Real-world photographs have been used repeatedly in the related literature to serve this purpose. Experiments 1 to 8a used outdoor (1 and 2) and indoor (3 to 8a) real-world photographs as they can be (relatively) easily divided into these two areas. They are also work well with a range of tasks, such as preference, focal recognition, and searching for an object tasks. In addition, one can claim that, when comparing this type of photograph with other types, they are more ecologically valid.

2.2.1 Construction of stimuli.

The photographs in most experiments were captured using a 10-megapixel Canon Power-Shot E1digital camera, with the size ranging from 60–100 bytes, the pixel dimensions were provided to the stimuli of each experiment. In Experiments 3 and 4, as the tasks were to find an object and to spot the difference between a pair of images, the camera was held in position on a tripod, and the changes or the differences in these experiments were made by physically changing the object or its location, or replacing one object with a new one. In Experiments 1 and 2, some of the photographs were obtained from commercially available collections, and open and free images resources with a minimum of 1200 pixel in width and height. In Experiment 2, for the purpose of testing the ability to recognise the focal objects, images were manipulated so the focal object could be placed on a new background or vice versa using the software Adobe Photoshop; this program was also used in two of the small experiments in Chapter 6 to arrange arrays of objects on a white background.

2.2.2 Criteria for stimuli.

Photographs used in the current work had neutral content, as the content in the most stimuli were kitchen appliances or bathroom accessories, or outdoor scenes with no people present in the scenes. In most experiments, three friends of the researcher gave neutral response on emotionally negative vs. positive 7-points scale. This is because it has been well established that emotional content has a serious impact on attracting eye fixations (e.g. Humphrey, Underwood, & Lambert, 2012), and we did not want such factors to confound our results. Focal objects were—in general—the most obvious objects in the scenes, which located in the centre, on an adequate number of background objects, as the researcher asked three friends to pinpoint the focal object on each scene, and they all agree on it.

In addition, focal objects were matched across location "most of the time in the middle of the photograph" and size where possible. This was done when taking pictures of each experiment, as the researcher chose focal objects with relatively similar size, and was placed on almost the same location. Matching on the low-level features of the stimuli in some experiments was also performed using a saliency map model. The concept of *salience*, within a visual scene, generally refers to the features that are likely to attract fixations independently of the task requirements or the participant's knowledge. Attention is drawn, in a bottom-up manner, by low-level visual properties of features, such as colour, intensity, contrast, and edge density. These processes have been modelled using Saliency Map techniques, and Experiments 2, 5 and 6 made use of the Itti and Koch's (1999) bottom-up model. This model is a computational implementation of saliency map processing that is based on three feature dimensions: colour, orientation, and intensity contrasts of the image. The saliency map is produced by a long process using a number of different spatial scales: four to encode 0, 45, 90 and 135 orientations, and an intensity channel, and red/green and blue/yellow channels. In each feature, the map represents the difference between high and low spatial frequency levels. For shifting the focus of attention, winner takes all (WTA) network is resetting a combination of local and global inhibition mechanism that allow a selection of new region to be the focus of attention (Duchowski, 2007).

Finally, the model combines this by using a number of parameters that can be set manually, such as the size of the focus of attention and the weight given to the feature channels. The pre-set standard parameters by the model were used for these experiments, for two reasons: firstly, they are known to represent efficient estimates of the resolution of human visual attention; and secondly, the aim of using this model was an attempt to control the focal objects with regard to their likelihood of receiving fixations based on their low-level features in the four conditions investigated. Any aim of using this model other than to be certain that the saliency features of focal objects cannot explain any differences in the accuracy of recognizing them among conditions was out of the purpose.

By analysing the stimuli one at a time into the model, we recorded the ranks given to the focal area: the ranking was based on the number of shifts it takes the model to choose the location. The focal area in each stimulus received at least one of the first three ranking points. The means and standard deviations after averaging the ranking points in every condition will be presented in their related chapters.

2.3 Apparatus and Eye Tracking Methodology

For Experiments 1 to 7, an eye tracker was used to record eye movements as an index of the allocation of visual attention when performing the tasks. According to Poole and Ball (2005), eye tracking is the technique of measuring an individual’s eye movements in order to be able to know where the person is looking at any given time, and the sequence of their fixations when inspecting visual stimuli.

2.3.1 Apparatus.

Eye movements were recorded with an EyeLink II system (SR Research, Mississauga, Canada), which monitors eye position of the pupil in one or both eyes using three infrared cameras mounted on a leather padded headband, Figure 2.1 Illustrate EyeLink equipment. Two of the cameras take images of the eyes every four milliseconds with up to 500-Hz binocular eye monitoring, and the third camera monitors head position by tracking four infrared markers positioned at the corners. In order to minimise head movements, and to ensure a constant viewing distance (57 cm from the monitor), a chin rest was used and participants were asked to remain stationary while performing the tasks. EyeLink II has the highest resolution, with noise limited at <0.01°, and fastest data rate (500 samples per second), compared with any other video-based eye tracker.

The EyeLink II system uses two interacting computers. The first computer is to control the presentation of stimuli as viewed by participants on a screen of dimensions 40 x 30 cm. The second computer controls the recording of the participant’s eye movements and it stores these data. Responses were entered using a keyboard, and all eye tracking experiments were created using SR Research Experiment Builder software.

Figure 2.1. Illustration of EyeLink equipment: Binocular head-mounted with Camera Setup Screen and Display Computer**.**

2.3.2 Calibration procedure.

The eye trackers have to be well calibrated to an individual's eye movements in order to record and analyse data (Duchowski, 2007; Poole & Ball, 2005). Before each eye tracking experiment, a calibration procedure was performed. After setting up the participant and the eye tracker, participants were asked to monitor a dot that appeared in nine different locations one at a time: this was to allow the device to explore gaze location from the eye's pupil center image. These locations provided a means to put the viewer's pupil position at extreme viewing angles, e.g., upper left/lower right. When calibration finished, the diagnostic was given; if the performance was poor, calibration was repeated. Then, a validation procedure was performed, which calculated the mean error between the actual point position and the computed eye's pupil position. If this was greater than 5°, then calibration was repeated. At the beginning of each trial, to check for any small drift that could occur due to headband slippage, or slight head movements, a drift correction appeared; this was a fixation point in the center of the screen. Participants were instructed to fix on the drift correction target at the beginning of the experiment. When the target was not detected, calibration was repeated.

2.3.3 Data analysis.

EyeLink II integrated all of the data collected into EDF files. These data files contained eye position samples, and eye movement events, which recorded eye position changes, identified by the EyeLink II on-line parses, and automatically turned these events into saccades, fixations, and blinks. For each sample, the parser computed velocity and acceleration to compare them to the velocity and acceleration thresholds. If either was above the threshold, the event was classified as a saccade. The resting point between saccades was identified as a fixation, which is the eye movement that stabilizes the retina over an area of interest (Duchowski, 2007). In addition to the measures derived from the data file that were computed using EyeLink DataViewer, keyboard responses and reaction times were recorded.

For all experiments, the location of fixations was extremely important, as the main question of the current thesis is whether individuals from different cultures give different levels of visual attention to focal and background regions in a scene. The focal area in all eye tracking experiments was identified using the EyeLink DataViewer software tool; defining focal area made it possible to allocate the number and duration of fixations that fell within the focal region and those that fell on the background. These two measures, as Chue et al. (2005) argued, directly reflect the allocation of attention: a higher number of fixations in a specific area indicate that this area is more important to the viewer (Poole et al., 2004). The duration of fixations was found to be longer on the informative regions of the scene (Rayner, 1998; Henderson & Pierce, 2008). Further, related literature has shown that the patterns of these two measures on focal/background areas vary significantly across cultures. However, other eye movement measures have sometimes been investigated and they will be described at the appropriate point. The next section will discuss the scanpath analysis as a measure also used in a number of experiments.

All eye movement measures were averaged across trial, and then means were subject to repeated measures mixed ANOVA with a between-subject factor of culture (Saudi vs. British groups) or prime (individualist vs. collectivist prime), and within-subject factors of stimulus (focal and background). Independent t-tests were used to reveal the direction of any significant interaction between culture and area of interest. All statistical tests were two-sided, and all reported differences were significant at the $p < .05$ level or better. The Pearson product-moment correlation coefficients were computed to assess the relationships between some of the eye movement measures or RTs to visual stimuli and the tested independent variables such as EFT and independent/interdependent self-construal.

2.3.4 ScanMatch.

For Experiments 3,4 and 5, scanpath analysis was performed using ScanMatch (Cristino, et al., 2010), a technique that is based on the Needleman-Wunsch algorithm. It is a method used to quantitatively [score] two sequences of eye movements (Cristino, et al., 2010) and was originally used in bioinformatics to compare DNA sequences. It incorporates spatial location, sequential information and temporal duration to create a sequence of upper case/lower case letters. The fixation sequence is spatially and temporally binned then recoded to create a sequence of letters that retains fixation location, time, and order information. The comparison of the two sequences is made by maximizing the similarity score computed from a substitution matrix, which provides the score for all letter pair substitutions and a penalty gap. The substitution matrix gives a meaningful link between each location coded by the individual letters, which could be distance or any useful dimension, such as perceptual or semantic space. One advantage of this model is to take into account the duration of fixations with the other two variables.

In Experiments 3,4 and 5, fixations were spatially binned in 16 x 12 bins, with each spatial bin sized 2° high and wide, the substitution matrix was based on the distance between each bin with a 3.5 cut-off value, and with a gap value of zero (Appendix A provides an example of the functional MATLAB code). A similarity score is the result of comparing the sequences of two eye movements. As a result of normalizing the score of the two sequences, the maximum possible matching score between two sequences of eye movements is one. A similarity score near to one means that the two sequences of eye movements are very similar and that near to zero means that they are dissimilar.

In order to be able to compare the ScanMatch scores of Saudi and British groups, we created three types of comparison: (a) intra-group comparison of Saudi group named S–S comparison, which compared the score of each Saudi participant with each participant of his/her cultural group; (b) intra-group comparison of British group named B–B comparison, which compared the score of each British participant with each participant of his/her cultural group; and (c) inter-group comparison named S–B comparison, which compared the score of each participant from one cultural group with each participant of the encounter cultural group. In the prime method experiment (7), the collectivism/individualism prime groups replaced the actual cultural groups. These comparisons were carried out for every stimulus, and then averaged across the conditions. This approach of arranging ScanMatch data was previously used by Miellet et al. (2010), and Madsen et al. (2012) and as it provides a means of comparing the scores of different groups with each other, which adds a greater value to the scores than when comparing them with absolute scale. Any further differences from what has been presented in the current chapter will be discussed at the relevant point.

Chapter 3: Cultural Differences in Preference and Recognition Tasks

3.1 Introduction

As discussed in Chapter 1, the role of culture in scene perception is a topic of current debate. The literature reflects conflicting opinions about this issue, as a small number of studies have failed to establish any cultural differences in scene perception (see for example, Evans, Rotello & Rayner 2009; Rayner, et al., 2007). Thus, the main aim of the present chapter is to contribute to the existing work devoted to answering the question of whether these differences exist, using another culture that has been neglected in this field, which although it has some similarities to Eastern cultures, it also has different characteristics that make it worth investigating.

In Experiments 1 and 2, we compared Westerners (British) with Saudi participants. The majority of previous studies have compared Westerners with East Asians in their tendency to focus on focal objects or the backgrounds of visual stimuli. To the best of our knowledge, only one study considered the Middle Eastern region. Abed (1991) investigated the differences in the number of saccades from left to right and from right to left between three cultural groups, i.e., Westerners, East Asians and Middle Easterners—who have three different reading and writing strategies—and found that Middle Easterners had the highest number of saccades from right to left, suggesting that their reading and writing habits had an effect on saccadic eye movements. In Experiment 1, we aimed to explore the possible differences between the two cultural groups using this measure.

Underwood, Foulsham & Humphrey (2009) (discussed in section 1.2.1) found that American Studies students were more accurate at recognising old American Civil War pictures, compared to engineering students, who were more accurate in the recognition of engineering pictures. This study arise an interesting question regarding culture, which is whether pictures that represent an individual's specific cultural context will have an effect on eye movement measurements and recognition than icons from another cultural context, or icons that are not related to any specific culture, in a way that similar to that of contents representing one's own specialist as found in Underwood, Foulsham & Humphrey (2009) study. With a note that most of the studies in this field have used cultural neutral scenes as stimuli, one would question the effect of the scene content on how people from different cultures will perceive it. A study conducted by Miyamoto, Nisbett & Masuda (2006) showed the effect of image's content on visual attention, as this study used Japanese and American scenes to prime participants to the physical environments related to these cultures found that participants who were primed to Japanese scenes were more able to detect changes between two images presented in a sequence using a change blindness paradigm compared to those who were primed to American scenes, and explained this better performance by the content of the Japanese scene as they contained more cluttered visual environment that broaden their attention span. We therefore, and to test the effect of familiarity with the content of the scene in the current experiments, used pictures representing Arabic culture and pictures representing Western culture, as well as neutral pictures that were free from cultural connotations to find out how they would influence the perception of the scene.

As it discussed in Chapter 1 (section 1.2.1) eye movements in scene perception studies have shown that they are highly affected by the nature of the task (e.g., Underwood, Foulsham & Humphrey, 2009). In Experiment 1 and the first task of Experiment 2, the task was similar to that highlighted in Chua, Boland & Nisbett (2005), which asked participants to provide a rating on scale of 1–7 concerning how much they liked the pictures and found that the American participants fixate more and for a longer period of time on focal objects than the Chinese. The preference task likely avoided attention being directed to a specific area within pictures, which it should; meanwhile maintaining participants' attention during the entire experiment. The second task in Experiment 2 followed the methods previously used for presenting stimulus for object recognition tasks. Chua et al. (2005) and Goh, Tan & Park (2009), in their focal recognition tasks, aimed to establish where the influence of culture occurs, whether it is in the encoding and retrieval stages or if it is only in the knowledge reporting. Their task was to make old/new judgment on original and new objects that presented on their original backgrounds or new backgrounds. Pictures in other words in this task are presented under four conditions: previously seen object on original background, previously seen object on new background, new object/original background and new object/new background. When comparing this task with that used in Masuda & Nisbett (2001) study, which found that Japanese reported 60% more background elements when reporting the previously seen underwater stimuli compared to the Americans, we can clearly see that the later task does not eliminate the possibility that the cultural difference obtained were due to the differences in reporting bias, not in the encoding and retrieval stages of processing, while in the focal recognition task one can claim that any differences found will be due to the effect of culture of the recalled information from the memory. If the results of preference and focal recognition tasks complemented each other in terms of cultural effects, such as finding that more and longer fixations in the first task is supported by more accuracy at recognizing previously seen focal objects, it would emphasise the role of culture on scene perception and contributed efficiently to the work devoted to this area.

In sum, the primary aim of the current experiments was to gain a better general insight into whether cultural differences in scene perception really existed using different cultural group, “Saudi culture,” that although it shares some similarities with Eastern cultures, it has on the other hand some uniqueness that makes it worth investigation. The current experiments also aimed to find out the extent to which cultural influence are present using a preference task that does not seem to direct attention toward any specific areas of stimuli, and using focal recognition task to find out whether culture is influencing the recalling of visual information not only the inspecting behaviours.

3.2 Experiment 1

Although cultural variation in eye movements during scene perception remains a debated topic, recent evidence suggests that culture is likely to have a certain impact on scene perception, as Western culture tended to attend more on the focal objects, while Eastern culture attended more to the context (e.g., Masuda & Nisbett, 2001, 2006; Miyamoto, Nisbett & Masuda, 2006); however, there is little sufficient data on visual attention in general and about scene perception in particular in the context of the Middle East. As discussed in Chapter 1, section 1.3.4 Saudi culture is classified as a collectivist culture, and Saudis tended to process information holistically (Alaifan, 2009). As such, and according to the previous studies that discussed in Chapter 1, section 1.3.1, which explained the differences between Westerners and East Asians on scene perception by the differences between these two cultures in analytic/holistic cognitive styles (e.g., Miyamoto, Nisbett & Masuda, 2006, Chua, Boland, & Nisbett., 2005; Goh, Tan & Park, 2009), it is expected that Saudi participants—based on their tendency to show more holistic cognitive style—will attend more to the whole scene instead of focusing on the focal area, on other words, they will pay more attention to the relationships between objects and the background within scenes when compared to the British. In terms of eye movement behaviours, they will have a higher number of fixations on the background than British participants and will also spend more time fixating on the background. Saccadic movements inside each region "focal/background" and from region to region in each stimulus are also expected to differ between the two groups. We have, however, no prior expectations regarding the direction of these differences.

To sum up, two general hypotheses addressed in Experiment 1, which are, firstly, the backgrounds of all pictures will receive more and longer fixations within the Saudi group than in the British group and the focal objects will receive more and longer fixations in the British group compared to the Saudi group. Secondly, pictures that represent individuals' culture will have an effect on eye movement measures.

3.2.1 Methodology.

3.2.1.1 Participants.

Fifteen Saudi participants (age $M = 24.64$, $SD = 2.75$, 9 females, 9 males) and 15 Britain participants (age $M = 21.23$, $SD = .703$, 14 females, 1 male) were recruited by posters and by the Research Participation Scheme system. None of the Saudi participants have lived in the United Kingdom or any other Western countries for more than two years. All of the participants were students at the University of Nottingham and had normal or corrected-to-normal vision. They were paid an inconvenience allowance and gave informed consent. The University's ethics committee approved the protocol.

3.2.1.2 Material and apparatus.

Sixty digital real-world photographs were prepared in three groups of 20 photographs, with each sub-group representing different category. The three categories were: Saudi, British, and Neutral Pictures (Figure 3.1). The British pictures were obtained from a CD-ROM collection, while a Saudi photographer took the rest. Each photograph consisted of focal object located on the center on background elements. The display resolution was set to 640 x 416 pixels.

Figure 3.1. Examples of British, Saudi, and Neutral pictures, from left to right.

3.2.1.3 Apparatus.

Eye movements were recorded with a SR Research EyeLink II system, which was also used to collect keyboard responses to each display. Participants responded by pressing keys on a keyboard. The experiment was controlled with SR Research Experiment Builder software.

3.2.1.4 Design.

The experiment used a between-subject factor (Saudi-British groups) and a within-subject factor of stimulus (focal/background). The three categories of the photographs were also taken into consideration in the analysis process. The independent variables were cultural groups, the area of interest (focal/background), and the pictures' categories (from Saudi Arabia, from Britain, and culturally neutral pictures), the dependent variable measures were: the number of fixations in the two areas "focal/background"; the duration of fixations in the two areas; the number of saccade movements from focal area to focal area "saccadic movements inside the focal area that defined using two methods described in the results section," from focal area to the background, from background to the focal area "saccadic movements between the two regions of the stimuli," and from background to the background area "saccadic movements outside the region that defined as focal area."

3.2.2 Procedure.

After a calibration procedure, participants were given written instructions and an information sheet. Participants then completed the consent form and were told they would view a series of pictures one at a time to judge the degree to which they liked each picture. Before each picture was presented, a small black circle (the fixation dot) appeared at the center of a white screen for 500 ms, and participants were asked to fixate on it. Then, a picture appeared in the center of a white screen, and participants were told that they could move their eyes to examine it. After 3000 ms, the picture disappeared, a grey display showing a rating scale appeared, and participants entered a number from 1–7 to indicate the degree to which they liked the picture (7 for don't like at all; 1 for like very much). All participants saw the same pictures in a different random sequence, and the experiment lasted approximately 15–20 minutes.

3.2.3 Results.

To measure the number of fixations, the duration of fixations in the area of interest (AOI) and in the background, and the number of the four saccades movements, a rectangle (320 × 208) pixels, (see Figure 3.2) was created in the center of each picture. In addition, a separate analysis was conducted for only 18 pictures, which had salient focal objects that were easily discriminated from their respective backgrounds when compared to the rest of the photographs. The results for both analyses are hereinafter presented separately.

3.2.3.1 Data analysis for all pictures.

The data from four Saudi participants were excluded from analysis due to poor calibration. The statistical analyses were made using SPSS and mainly included mixed ANOVAs, with cultural groups as the between-subjects factor and the area of interest (focal/background) and picture categories (Saudi, British, and Neutral pictures) as the within-subjects factors. First, the average number of fixations will be presented, followed by the average fixation durations, and then the saccades lengths; a similar order will be followed in the second analysis.

3.2.3.1.1 *Mean number of fixations.*

For the mean number of fixations in the three categories (Saudi, British, and Neutral), see Table 3.1. Both groups did fixate on the focal area more than on the background, [$F(1, 28) = 33.44$, $p < .001$]. Both groups made more fixations on the focal area of Saudi pictures ($M = 6.39$, $SD = 1.48$; M = 5.98, $SD = .90$ respectively), [$F(1, 28) = 77.07$, $p < .001$]. However, neither the main effect of culture [$F(1, 28) = .03$, $p = .86$], nor the interaction between the within-subject factors and cultural group, were significant, [$F(1, 28) = 1.41$, $p = .25$ for the interaction between culture and picture categories & $F(1, 28) = 1.96$, $p = 17$ for the interaction between culture and AOI, and $F(1, 28) = .55$, $p = .58$ for the interaction between culture and the two within subject factors].

3.2.3.1.2 Mean duration of fixations.

For the mean duration of fixations in the three categories (Saudi, British, and Neutral), see Table 3.1. Both groups did fixate on the focal area for longer period of time than those in the background [$F(2, 56) = 7.742$, $p < .001$]. Both groups made longer fixations on the focal area of neutral pictures ($M = 328.85$ ms, $SD = 61.19$; $M = 303.36$, $SD = 61$ respectively), [$F(1, 28) = 63.709$, $p < .001$]. However, the main effect of culture was not significant [$F(1, 28) = .51$, $p = .48$], also the interaction between culture and AOI, $F(1, 28) = .43$, $p = .52$ was not significant. Finally, neither the interaction between culture and picture categories [$F(1, 28) = .40$, $p = .67$, nor for the interaction between culture and the two within subject factors $F(1, 28) = .41$, $p = .66$ was significant.

Table 3.1.

Means for number of fixations and duration of fixations (milliseconds) in three conditions on the area of interest and background for British and Saudi Groups, numbers in the parentheses represent SD.

	Number of Fixation			Duration of Fixation		
	Saudi	British	Neutral	Saudi	British	Neutral
	Focal back	Focal back	Focal back	Focal back	Focal back	Focal back
British	6.39 1.84	5.93 3.95	5 4.44	305.55 243.11	296.38 246.43	328.86 261.26
Group	(1.48) (1.96)	(1.15) (.79)	(1.31) (4.63)	(62.15) (64.58)	(64) (69.1)	(61.19) (59)
Saudi	5.99 2.07	5.54 4.45	5 4.81	284.5 238.55	287.5 235.78	303.36 248.38
Group	(.90) (.54)	(.95) (1.16)	(.99) (1)	(65.97) (58.68)	(56) (53.88)	(61.1) (59.22)

3.2.3.1.3 Saccade movements.

The same repeated ANOVA was conducted on each of the number of the four saccades movements, with cultural group as a between-subject factor, and picture categories "Saudi, British, Neutral" as a within-subject factor. For saccades from focal to focal region, the analysis showed that there was a significant effect of picture categories, [$F(2, 56) = 12.24$, $p < .001$]. Saudi pictures had a higher number of saccades ($M = 4.1$, $SD = .93$) than other categories; British and Neutral pictures ($M = 3.74$, $SD = .70$; $M = 3.54$, $SD = .79$ respectively). However, neither the main effect of culture $F(1, 28) = 2$, $p = .17$, nor the interaction between the within-subject factor and culture was statistically significant, $F(2, 56) = .21$, $p = .81$. For saccades from the focal area to the background, the analysis also showed that there was a significant effect of picture categories, [$F(2, 56) = 6.77$, $p = .002$]. Saudi pictures had a lowest number of these saccades ($M = 7.91$, $SD = 2.74$) than other categories; British and Neutral pictures ($M = 9.88$, $SD = 4.92$; $M = 9.87$, $SD = 3.68$ respectively). However, neither the main effect of culture $F(1, 28) = 1.63$, $p = .21$, not the interaction between the within-subject factor and culture was statistically significant, $F(2, 56) = 1.44$, $p = .25$. Finally, none of the effects for the saccades starting from background to the focal area and from background to the background were significant, [$F(2, 56) = 1.72$, $p = .19$, & $F(1, 28) = 1.51$, $p = .23$ & $F(2, 56) = .46$, p = .64] for the main effect of picture categories, the main effect of culture, and the interaction between picture categories and culture on saccades from background to the focal, and [$F(2, 56) = .41$, $p = .66$, $F(1, 28) = 12.24$, $p = .50$ & $F(2, 56) = .34$, $p = .72$] for the main effect of picture categories, the main effect of culture, and the interaction between picture categories and culture on saccades from background to the background area.

3.2.3.2 Data analysis for eighteen pictures.

In each of the eighteen pictures, a rectangle, which had been used in the previous analysis, was removed, and a tool in the data viewer software was used to precisely define the focal objects as areas of interest (see Figure 3.2). The new set of data was tested using ANOVA with cultural group as a between-subject factor and the area of interest (focal, background) as a within-subject factor. The picture's categories "Saudi-British-Neutral" was no longer considered, due to the fact that most of the 18 photographs chosen in this analysis were from the neutral category. For all participants (Table 3.2), the mean number of fixations on the area of interest (AOI) was greater than that on the background, $F(1, 28) = 10.323$, $p < .001$. On the other hand, the mean fixation durations on the background was longer than that on the AOI, $F(1, 28) = 186.331$, $p < .001$. Although the between-subject factor in the two measures showed no significant effect, $F(1, 28) = .51$, $p = .48$, for the number of fixation, and $F(1, 28) = .20$, $p = .66$, the interaction between the area of interest and the cultural group was statistically significant in the two measures, $F(1, 28) = 4.953$, p $< .05$ for the number of fixations and $F(1, 28) = 5.072$, $p < .05$ for the duration of fixations. Independent t-test was then carried out between the two cultural groups for comparison of means of the four measures: (a) duration of fixations on the AOI; (b) the duration of fixations on the background; (c) the number of fixations on the AOI; and, (d) the number of fixations on the background. Only the fixation durations on the AOI and the number of fixations on the background (Figure 3.3) revealed statistically significant differences among the groups, t (28) = -2.38, $p < .04$, and t (28) = 2.11, $p < .05$, respectively. Saudi participants ($M = 4.86$, $SD = 1.1$) made more fixations on the background than British participants ($M = 4.18$, $SD = .58$), whereas British participants (*M* = 185.96 ms, *SD* = 19.8) made longer fixations on the AOI compared to Saudis (*M* = 163.74 ms, *SD* = 30.2). However, no significant differences between the groups was found in the number of fixations in the focal area, t (28) = -.89, *p* = .39, and also on the fixation durations in the background t (28) = 1.63, *p* = .11.

Table 3.2.

Means for number of fixations and duration of fixations (milliseconds) on the area of

	Number of Fixation		Duration of Fixation	
	Focal	Back	Focal	Back
British	5.39	4.18	185.96	318.85
Group	(0.64)	(0.58)	(19.81)	(49.35)
Saudi	5.1	4.89	163.74	349.14
Group	(1.22)	(1)	(30.23)	(52.39)

interest and background for British and Saudi Groups (18 Pictures), numbers in the parentheses represent SD.

Figure 3.2. Samples of rectangle and an AOI analysis tool

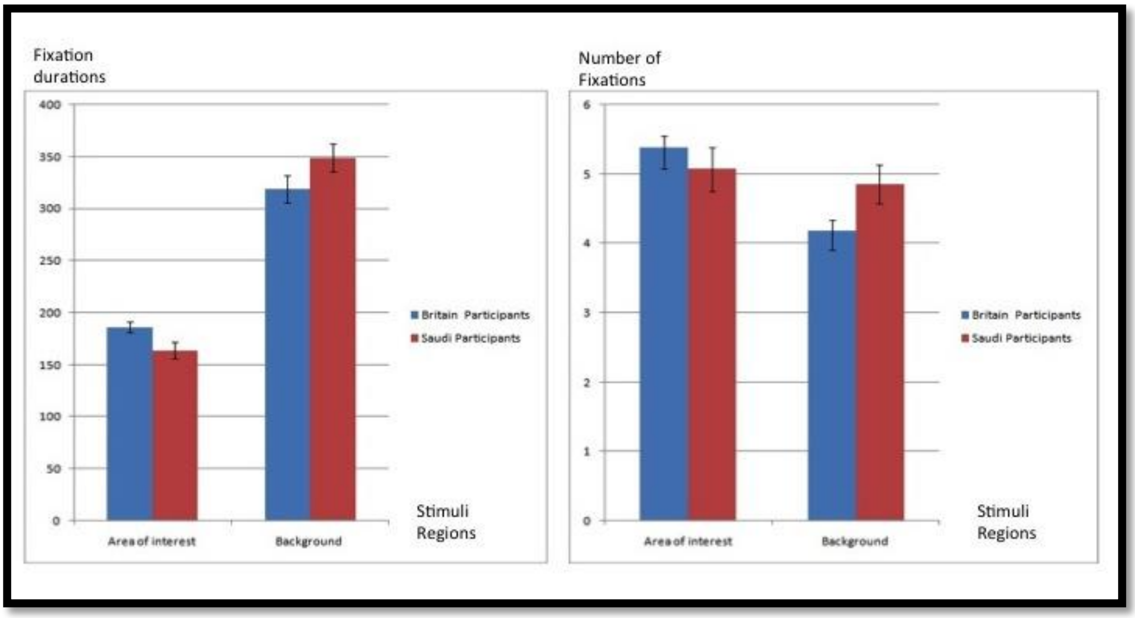


Figure 3.3. Means for number of fixations on the areas of interest and backgrounds for British and Saudi groups on the left, and on the right means for fixation durations on the areas of interest and backgrounds for British and Saudi groups, error bars represent standard error.

An independent t-test with alpha adjusted to 0.013 for multiple comparisons “4 levels” was performed between groups to compare the means of the four saccades movements (from AOI-AOI, AOI-background, background-AOI, and background-background). Results showed no significant differences among the groups in the four measures, t (28) = -.91, p = .34 for the saccades from AOI to AOI, t (28) = 1.49, p = .37 for the saccades from AOI to background, t (28) = .78, p = .44 for the saccades from background to AOI, and t (28) = -1.28, p = .21 for the saccades from background to background.

3.2.4 Discussion.

The primary aim of the current experiment was to determine whether cultural differences exist in scene perception. Saudi participants were expected to have more fixations on the background compared to the British, while the British group was expected to have longer fixation durations than Saudis in the focal area. Contrary to the expectations, the first set of analyses did not detect any significant differences between the British and the Saudi groups in any measure. These findings showed that eye movement measures were similar between British and Saudi groups, which suggested that cultural differences do not play an important role in scene perception.

Although these findings are not what were hypothesized, three main issues should be taken into consideration before rejecting our hypothesis. The first point pertains to the complexity and composition of the pictures; some pictures had one large object covering more than 50% of the picture (most of the pictures in the Saudi category), which can act as a focal object in an almost blank background, while other pictures had multiple focal objects against complex backgrounds. This may have affected visual encoding of the stimuli, as Rayner et al. (2007) found that pictures consisting of multiple objects do not reflect any cultural differences in terms of the number of fixations. Boland et al. (2008), in their reply to Rayner et al. (2007), emphasized the necessity of using pictures consisting of one foreground object against a rich background. Only 18 pictures from the current study matched, to a certain degree, this description; these were used in the second set of analyses.

The second issue is the division that has been used to distinguish the two areas (center, background) inside pictures. The rectangle division of the pictures may reflect a central tendency bias (Tatler, 2007). Zelinsky et al. (1997) found that participants initially directed their eyes to the center of the stimuli, regardless of any other conditions. Furthermore, the rectangle, as Boland et al. (2008) pointed out, is likely to contain a number of objects and their surrounding area, which means that it would contain information that should belong in the background.

The third issue is Saudi subjects who have spent, on average, more than one year in the UK. Some studies have shown that changes in perception tasks could occur after relocating and immersing oneself in another culture for more than a year (Kitayama et al., 2003). In order to overcome this problem in future experiments, spending less than one year in the UK or other Western countries would be an important condition for eligibility for Saudi participant selection. Given this potential limitation, the findings of the first analysis should be interpreted with caution.

The second hypothesis was that pictures that represent individuals' own culture would affect the number of fixations and fixation durations of these individuals. The result, however, showed no interaction between culture and picture categories in the two groups; therefore, we are unable to demonstrate that there is such an interaction at this time. Based on the problems mentioned earlier pertaining to the composition of pictures, this hypothesis should be further examined. The results also showed that picture categories had a significant effect on both the number and duration of fixations. One possible explanation for this effect is that pictures in the current experiment were generally composed differently. As mentioned above, different compositions, and the comparative simplicity or complexity of their content, could play an important role in eye movement behaviour.

In the second set of analyses, the results showed significant differences between British and Saudi participants in the number of fixations on backgrounds and on the durations of fixations on the focal objects. In terms of the number of fixations, this result is in agreement with what was hypothesized: Saudi participants showed a greater number of fixations on the background. This finding supports those of previous studies that have revealed strong evidence for Saudi individuals tending to adopt a holistic cognitive style (Alaifan, 2009), which is one of the main interpretations for the differences between Westerners and Easterners in their fixation behaviour. This result also is in agreement with Chua et al. (2005), who found that East Asians looked at backgrounds more than Americans. Additionally, the British group findings in this experiment which revealed that they tended to fixate on the AOI for a longer period of time is consistent with Goh, Tan & Park (2009) study, who found that the American participants had longer durations of fixation on the focal objects in comparison to the Singaporean participants. In general, the findings of the second analysis were partly consistent with prior studies found in the available literature. Saudi participants looked at the background more than did the British, and Saudis spent less time looking at the focal objects.

These findings provide some support to the first hypothesis given for the current experiment, which was Saudi participants would have more number of fixations on the background and less time inspecting the focal area compared to the British based on their preference cognitive style. Considering the findings from the first set of analyses, one should recommend further research to firmly establish these differences obtained in the second set of analysis. The findings from the second analysis were partly consistent with prior studies in the literature, which mainly claimed that Westerners tend to fixate on the focal area for a longer period of time, and have a smaller number of fixations on the background. However, comparing the two sets of analysis, one may conclude that the rectangle method of distinguishing focal areas from background areas in pictures was not an appropriate method to use in this case; it may reflect, to a certain extent, a central bias, as both the groups looked more frequently, and for a longer period of time, at the central area. Thus, outdoor pictures with easily discriminative focal objects would be selected in Experiment 2.

A final note about Experiment 1 is that although preference tasks appeared to have been easily performed with no constrains that would direct eye movement behaviours to specific regions, the task can in a way be considered as vague in the sense of how much attention an individual need to allocate when performing it, if any. In the preference task, participants had no clear basis on which to rely when making their preference judgments. In other words, the basis on which they inspected the scenes may have been highly idiosyncratic and variable. Experiment 2 therefore incorporated two tasks: the first was primarily a replication of Experiment 1 with the stimuli adjustments discussed above, while a second task involved a focal recognition that required old/new responses to the focal objects, which was described in the introduction of this chapter. The results of the latter task aimed to provide an answer about whether these responses differed in terms of processing visual information. Additionally, comparing the eye movements in these two tasks served as a test of the stability of fixation differences across different tasks.

3.3 Experiment 2

Data from Experiment 1 suggested that Saudi groups looked for a shorter amount of time to the focal object and looked more to the background, compared to British groups. However, this analysis was affected by the restricted range of stimuli that were appropriately composed, and by the fact that Saudi participants in that experiment spent more than a year in the UK at the time of performance. Therefore, the first aim of Experiment 2 was to replicate Experiment 1 using better stimuli that consisted of focal object on a relatively richer background and with Saudi participants who only spent a year or less in the UK. Another eye movement measure will also be taken into account in the current Experiment, which is the time it takes for a participant to initially fixate on a specific area, as it indicates how much that area attracts their attention. This is why this measure has been used in another study to investigate cultural differences in scene perception (Evans, Rotello & Rayner, 2009).

The second aim of this experiment is to provide an opportunity for comparing eye movement data between a preference task and a focal recognition task, which was expected to contribute to the work devoted to clarifying whether cultural effects are accrued in the early stages of perception (encoding phase) and whether culture also affected the memory and retrieval stage (recognition phase) (e.g., Masuda & Nisbett, 2001) by influencing the accuracy of remembering the previously seen objects when they placed on new background. This comparison would provide valuable information about the extent to which eye movement behaviours can be affected by culture and task requirements. The results of the second task, which tested the accuracy at remembering focal object when it was placed on different background following the same task applied in previous studies (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2006; Goh, Tan & Park, 2009). This will provide an opportunity to discover whether accuracy results back up eye movement measures. As reported in Chapter 1, section 1.3.4 Saudi subjects tended to be more collectivistic and showed more holistic style (e.g. Alamri, Cristea, & Al-Zaidi, 2014; Alaifan, 2009); additionally, the above-mentioned studies showed that Easterners were more affected by background changes; as they were less accurate at recognizing focal objects when displayed on new background "see section 3.1 in the current chapter." It was therefore predicted that Saudi participants would be less accurate in terms of remembering objects when they were presented with new backgrounds, due to the fact that Saudi participants bound the focal objects to their contexts; as such, new backgrounds would potentially inhibit their memory. Thus, Saudi participants are expected to be less accurate at detecting old objects within an old object/new background condition more often than British participants.

The final aim of the current Experiment was to directly investigate whether the holistic-analytic dimension was one of the main mechanisms underlying cultural diversity in scene perception, which has been suggested by others (Peng & Nisbett, 2000; 2006; Masuda & Nisbett, 2001; Duffy, Kawamura & Larsen, 2003; Chua, Boland, & Nisbett., 2005). Westerners in these studies were more attentive to focal objects, while East Asians were more likely to attend to contextual information. This difference in attending to the focal verses to the whole, or to the context, was supported by the relative versus absolute judgment task (Kitayama, et al., 2003), which was fully described in Chapter 1, section 1.3.1.

This aim was achieved in the current experiment by separately administering the embedded figures test (EFT), which is commonly used to measure field dependence (holistic style) and independence (analytic style). The test was originally developed in 1950 by Witkin to measure an individual's ability to distinguish figures from their contexts. Individuals who spend less time finding figures are considered to be field-independent (analytic), while those who spend a longer time finding figures are considered to be field-dependent (holistic) (Witkin & Asch, 1984). This test has been applied to investigate cognitive styles across cultures, with results indicating that cultures that tend to be classified as collectivist (Malaysia/Russia) also tended to show a holistic cognitive style as they took a longer time to detect the embedded figures, whereas cultures that are shown to be individualistic (U.S./Germany) tended to exhibit greater analytical style, and took a shorter time detecting the embedded figures (Kühnen , et. al. 2001).

In order to investigate whether or not culture plays a major role in scene perception and to compare the accuracy for detecting the focal objects in four conditions "previously seen object on original background, previously seen object on new background, new object/original background and new object/new background" among these two cultural groups, the following measures were calculated in both the preference and recognition tasks for each participant: mean number of fixations on AOI and on background, mean fixation duration on AOI and on background, time to first fixation on focal object, as well as the accuracy in remembering it.

3.3.1 Methodology.

3.3.1.1 Participants.

Fifteen Saudi participants (age M = 25, SD = 2.73, 7 females, 8 males) and 15 British participants (age M = 22, SD = 3.40, 6 females, 9 males) were recruited through posters and email for this experiment. None of the Saudi participants have lived in the United Kingdom or any other Western country for more than one year: some of them were studying English courses in CELE, and the rest were students at the University of Nottingham. All participants had normal or corrected-to-normal vision. They were paid an inconvenience allowance, and gave informed consent. The school of psychology's Ethics Committee approved the protocol.

3.3.1.2 Material and apparatus.

For this experiment, we selected from commercially available collections and some open and free images resources with a minimum of 1200 pixel in width and height, a new set of 112 outdoor pictures with easily distinguishable focal objects, most of which were situated in the center of the picture. Before conducting the experiment, and to be more certain about determining objectively which pictures best represented each category—Saudi, British, and Neutral, we incorporated these pictures into E-Prime software. Using this software, British and Saudi volunteers were asked to press specific keyboard keys to indicate whether a particular picture represented scenes commonly associated with Arab or Western culture.

Pictures were categorized as Western (24 images) or Arabic (23 images) if at least 75% of participants placed them in that category, with a reaction time shorter than the mean reaction time for all pictures. Neutral pictures (27 images) were chosen through a number of steps; first, pictures received less than 70% of participants placed them in either the Western or Arabic category were chosen, and then, pictures with the participants' reaction times in categorizing them longer than the mean reaction time for all pictures were selected among the rest, as the longer reaction time suggest that participants had difficulty in deciding how to classify them, and finally, the chosen pictures were checked by the researcher to be certain that they could not be linked to any specific culture (e.g., underwater scenes).

To ensure that the focal objects in all pictures were equivalent, pictures were analysed by the saliency map model, a computational method created by Itti & Koch (1999) for analysing image properties. This model selects the regions that differ significantly from their surroundings (see Chapter 2, section 2.2.2 for a description of this model). Those regions are the salient points, which predict where a viewer will fixate on that image.

After analysing pictures by the saliency map model, we only included pictures in which the focal objects were found to be one of the three tops ranked points. In terms of bottom-up mechanism, by this step, we ensured that the focal object in each picture has the same opportunity to attract visual attention based on its visual features (Chapter 1, section 1.2.1). As a result, we selected 21 Arabic pictures (M = 3.23, SD =

1.23), 23 Western pictures (*M* = 3.46, *SD* = 1.40), and 20 neutral pictures (*M* = 3.45, *SD* = 1.32).

All photographs (64) had neutral contents with no disturbing yet no pleasuring content. The display resolution was set to 640 x 416 pixels. For the object recognition task, 60 photographs were used: 15 of these were repeated exactly from the previous phase (old/old condition), and 15 were entirely new, each with a single focal object against a realistic background (new/new condition). Thirty images from the previous phase were then manipulated using Adobe CS Photoshop software: 15 images were created from old focal objects and new backgrounds (old/new condition), and 15 consisted of new focal objects and old backgrounds (new/old condition). See Figure. 3.4 for the samples of the latter two conditions.

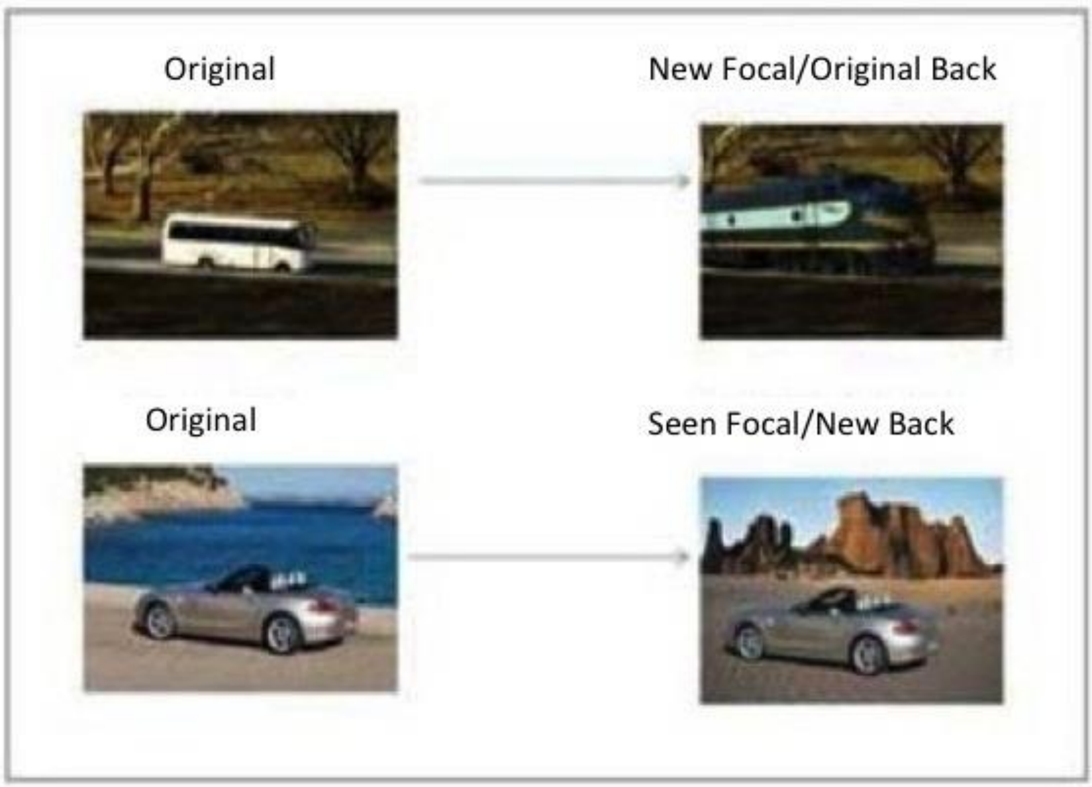


Figure 3.4. Examples of two conditions: new focal/original background & previously seen focal/new background.

Eye movements were recorded with an SR Research EyeLink II system, with a viewing distance set to 57 cm from the monitor. Participants responded by pressing keys on a keyboard in both phases of the test. The experiment was controlled with SR Research Experiment Builder software.

3.3.1.3 Design.

The experiment used a 2 x 2 x 3 repeated measures mixed ANOVA with a between-subject factor of nationality (Saudi, British groups), and within-subject factors of stimulus location (focal, background) and the three image categories (Arabic, Western, and Neutral). In the second phase, the four conditions of pictures (old-old/new-new/old-new/new-old) were also taken into account. The dependent variables were: the number of fixations on the two areas; the duration of fixation in the two areas; time to first fixation on the focal object in each category; and, in the second phase, the accuracy of recognizing the focal object in the four conditions.

3.3.2 Procedure.

3.3.2.1 Preference task.

After a calibration procedure, participants were given written instructions and an information sheet. Participants then completed the consent form. They were told that they would view a series of pictures in succession, and they were asked to judge the degree to which they liked each picture. Before each picture was presented, a small black circle (a fixation dot) appeared at the center of the display, and participants were asked to fixate on it. A picture then appeared in the center of a white screen, and participants could move their eyes to examine it. After 3000 ms, the picture disappeared. A grey display showing a rating scale appeared, and participants entered a number from 1–7 to indicate the degree to which they liked the picture (7 for don't like at all; 1 for like very much). All participants saw the same pictures in a different, randomised sequence, and this task lasted approximately 15–20 minutes. At this stage, participants were not told that there would be a memory task.

3.3.2.2 Focal recognition task.

First, participants were asked to do an irrelevant task (backward counting from 100) for 3 minutes, when some of them finished before the 3 minutes passed, they were asked to do it again. Saudi participants did the counting in Arabic. They were then shown six new neutral pictures in a sequence, and were asked to point out the focal object in each one, to test whether they were able to distinguish the focal objects from their backgrounds. After that, the calibration and the validation were performed again. Participants were told that they would be shown another set of pictures, and were asked to decide whether they had seen the focal object in the previous task. Participants then started the object recognition task. Before each picture was presented, a small black circle (a fixation dot) appeared at the center of the display, and participants were asked to fixate on it. A picture then appeared in the center of an off-white screen, and participants could move their eyes to examine it. After 3000 ms, the picture disappeared, and then they were allowed to press a key labelled 'YES' if they had seen the object before, and a key labelled 'NO' if they thought that the object was new. If they were not sure, they were instructed that they could make a guess. The 60 pictures were shown one at a time in a different, randomised sequence. See Figure. 3.5 for an illustration of these two tasks.

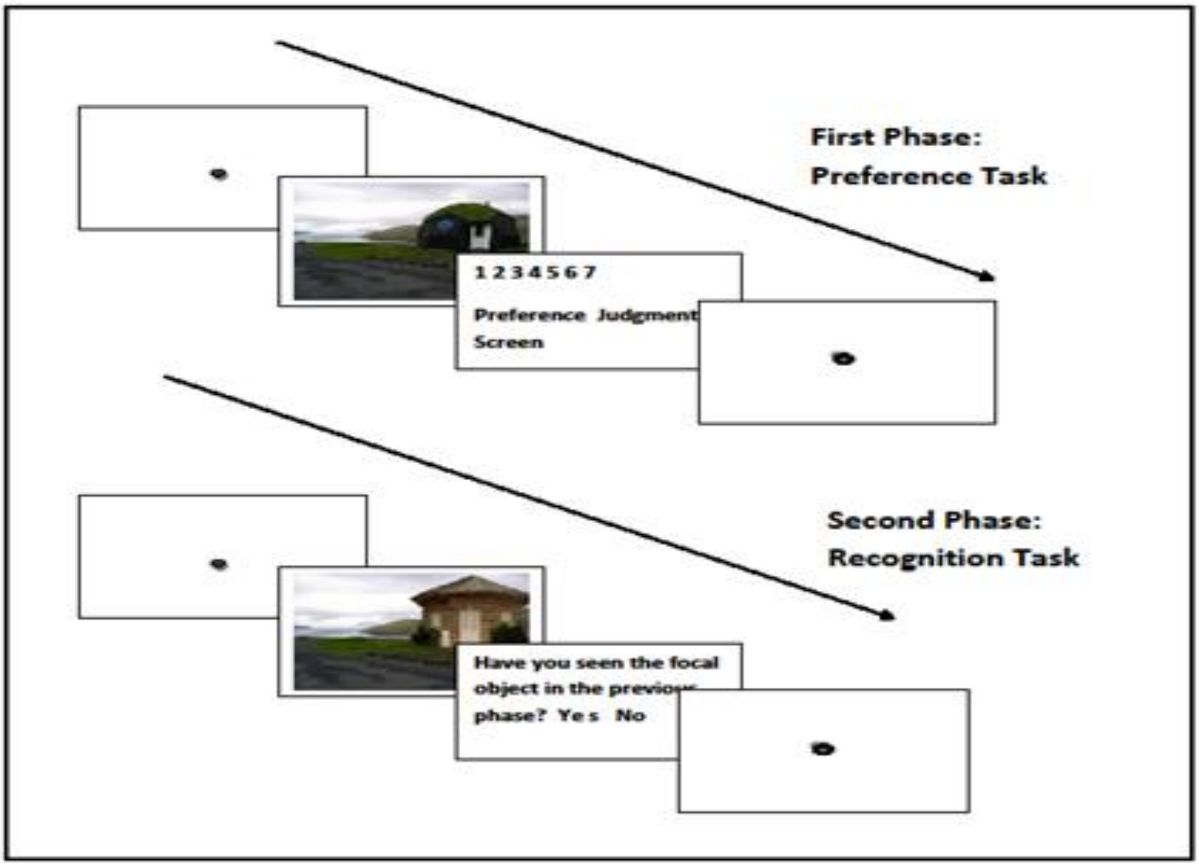


Figure 3.5. An illustration of the two tasks of the experiment.

3.3.2.3 Embedded figure test.

Participants were then asked to perform the EFT on a laptop. This test was originally developed in 1950 by Witkin to measure an individual's ability to distinguish figures from their contexts. Individuals who spend less time finding figures are considered to be field independent, while those who spend longer are considered to be field dependent (Witkin & Goodenough, 1977). Participants were asked to locate the small shape that embedded in larger, and more complex one. After the task was explained, participants first did a printed-paper figure for practice purposes, then the task started and they were shown the 11 figures in their original order. The time spent to find the simple form in each complex figure was recorded in order to calculate the average time spent detecting the embedded shapes in this test. Finally, participants were asked if they were familiar with this test; only four British participants said that they vaguely remember some of the figures. The whole experiment lasted for approximately 35–40 minutes.

3.3.3 Results.

The statistical analyses were carried out using SPSS, and mainly consisted of repeated mixed ANOVAs, with cultural groups (Saudi-British) as the between-subject factor and the area of interest (focal-background) as the within-subject factor. The picture categories (Saudi, British, and Neutral) was also taken into account as a within-subject factor in the preference task (Task 1). We will first present data on the mean number of fixations, mean fixation durations, time to first fixation on the focal object, and the percentage of gaze total durations in task one (Preference Task) and then the same order will be followed in the task two (Recognition Task). This will be followed by results on participants' accuracy in recognizing the focal object in the four conditions, and in the two conditions used for *A′* analysis. Finally, the results of the EFT will be presented.

3.3.3.1 Task 1.

3.3.3.1.1 Mean number of fixations.

The mean number of fixations on the focal and background in the three conditions for each group is presented in Table. 3.3. A 2 x 2 x 3 repeated mixed ANOVA was performed with cultural groups (Saudi-British) as the between-subject factor; the within-subject factors were the area of interest (focal-background) and the three picture categories (Saudi, British, and Neutral). These results demonstrated that both groups looked more at the focal object than the background in all three categories, $F(1, 31) = 68.24$, $p < 0.001$.   The results also showed a main effect of culture, $F(1, 31) = 9.25$, $p < 0.005$, in addition, the interaction between culture and AOI was significant $F(1, 31) = 14.78$, $p < 0.001$. An independent t-test, with alpha adjusted to 0.008 for multiple comparisons, revealed that Saudi group looked more at the background in all three-picture categories (t (31) = 5.895, $p < 0.001$ for Saudi pictures; t (31) = 4.969, $p < 0.001$ for British pictures; t (31) = 4.553, p < 0.001 for Neutral pictures). On the other hand, neither the effect of picture category nor the interaction between culture and picture category was significant [$F(2, 62) = 2.37$, $p = 0.10$, and $F(2, 62) = 2.41$, $p = 0.099$ respectively].

Table 3.3. *Mean number of fixations and mean fixation duration on the focal/background for the three image categories in British and Saudi groups (ms), numbers in the parentheses represent SD.*

	Number of Fixations						**Duration of Fixations**					
	Arabic(M/SD)		Western(M/SD)		Neutral(M/SD)		Arabic(M/SD)		Western(M/SD)		Neutral(M/SD)	
Area of Interest	Focal	Back	Focal	Back	Focal	Back	Focal	Back	Focal	Back	Focal	Back
BritishG	5.45	2.65	6.64	2.15	6.55	2.46	318.91	274.96	342.39	275.14	315.8	272.53
	(0.8)	(0.65)	(1.76)	(1.3)	(1.3)	(0.66)	(78.1)	(59.6)	(92.9)	(62.5)	(72.2)	(60.7)
Saudi G	5.24	4.91	6.69	3.98	5.8	4.14	281	248.1	294.49	246	276.31	236.35
	(1.17)	(1.44)	(1.66)	(1.28)	(2.03)	(1.36)	(63.8)	(59.6)	(58.3)	(61.2)	(47.2)	(47.1)

3.3.3.1.2 Mean fixation durations.

The mean duration of fixations on the focal and background in the three conditions for each group is presented in Table 3.3. A 2 x 2 x 3 repeated mixed ANOVA was performed with cultural groups (Saudi-British) as the between-subject factor; the within-subject factors were area of interest (focal-background), and the three pictures categories. The predicted pattern was found for the duration of fixations on the focal object. Table 1 showed that both groups looked at the focal object for a longer period of time, $F(1, 31) = 37.50$, $p < 0.001$. In addition, both groups looked for a longer time [$F(2, 62) = 6.25$, $p = 0.002$] at British pictures ($M = 289.51$, $SD = 11$) than at the Saudi pictures ($M = 280.74$, $SD = 10.33$). Both groups looked at the neutral pictures for a shorter time again ($M = 275.25$, $SD = 9.49$). However, culture did not have a statistically significant effect, $F(1, 31) = 3.27$, $p = 0.080$, nor did the interaction between culture and AOI, $F(1, 31) = 0.54$, $p = 0.47$. Furthermore, the interaction between cultural group and pictures category was not significant [$F(2, 62) = 0.340$, $p = 0.713$].

3.3.3.1.3 Mean time to first fixation

A 2 x 3 mixed ANOVA was conducted on the time to first fixation on the focal object, with the two cultural groups as the between-subject factor, and the three picture categories as the within-subject factor. The result revealed that picture category had a significant effect, $F(2, 62) = 36.93$, $p < .001$. It took participants the shortest time to fixate on the focal object in the Western pictures ($M = 337.50$, $SD = 75.11$), followed by the neutral pictures ($M = 410.83$, $SD = 107.73$), and finally the Arabic pictures ($M = 541.81$, $SD = 134.67$). The interaction between culture and picture category was significant, $F(2, 62) = 6.78$, $p < .002$. An independent t-test, with alpha adjusted to 0.017 “3 levels”, revealed the differences between the groups was significant only for the neutral pictures (t (31) = 2.421, $p < 0.05$), for which British participants looked at the focal object significantly sooner (*M* = 369, *SD* = 78.72) than the Saudis (*M* = 454.44, *SD* = 119.23). However, there was no main effect of culture on the time to first fixation on the focal object, $F(1, 31) = 0.052$, $p = .82$. Finally, when we performed an independent t-test on the average time to the first fixation on the focal object in all pictures, the significant difference between the groups disappeared (t (31) = 0.142, $p = .89$).

3.3.3.1.4 The percentage of total gaze durations

The percentage of total duration on the focal object was subject to a 2 x 3 repeated measures mixed-design ANOVA, with the two cultural groups as the between-subject factor and the three categories of pictures as the within-subject factor. The result showed that a picture’s category had a significant effect, $F(2, 64) = 26.92$, $p < .001$, as Western pictures had the highest percentage of total gaze duration on the focal object (*M* = 70.40, *SD* = 12.30), than the neutral pictures (*M* = 67.1, *SD* = 10.82). Arabic pictures had the lowest percentage of total gaze duration on the focal object (*M* = 54.76, *SD* = 12.50). The interaction between picture category and culture was significant, $F(2, 64) = 3.85$, $p = .026$: British participants had a significantly higher percentage of total gaze durations on the focal object in only neutral pictures (t (31) = 2.72, p = .01) (*M* = 71.71, *SD* = 6.7 for British participants; *M* = 62.49, *SD* = 12.32 for Saudis). However, the main effect of culture was not significant, $F(1, 32) = 2.13$, $p = .15$.

3.3.3.2 Task 2.

3.3.3.2.1 Mean number of fixations.

For the focal recognition task, (Table. 3.4) a 2x 2 mixed design ANOVA showed that both groups had by far the higher number of fixations on the focal area, $F(1, 31) = 149.26$, $p < .001$. However, neither the main effect of culture, nor the interaction between culture and AOI, was significant [$F(1, 31) = 0.013$, $p = .910$ and $F(1, 31) = 2.50$, $p = .124$ respectively].

3.3.3.2.2 Mean fixation durations.

For the focal recognition task (Table. 3.4), a 2x 2 mixed ANOVA was conducted, with cultural groups as the between-subject factor, and the two areas of interest as the within-subject factor. The results revealed that both groups looked at the focal object for longer than the background, $F(1, 31) = 81.16$, $p < .001$. There was a significant interaction between AOI and cultural groups, $F(1, 31) = 15.56$, $p < .001$. An independent t-test, with alpha adjusted to 0.025 for multiple comparisons “2 levels”, revealed that the differences between the groups in the duration of fixations on the focal object was slightly above the statistical significance ($t(31) = -2.362$, $p = .027$), as British participants looked at the focal object for longer than Saudis (Table 2). However, the main effect of cultural groups was not significant, $F(1, 31) = 2.81$, $p = .10$. An independent t-test on the average time to the first fixation on the focal object in this task was performed and the result also showed no significant difference between the groups ($t(31) = 1.02$, $p = .32$).

Table 3.4. *Mean number of fixations and mean fixation duration on the focal/background in the second task (ms), numbers in the parentheses represent SD.*

	Number of fixations (M/SD)		Time to first fixation (M/SD)	Duration of fixations (M/SD)	
	Focal	Back		Focal	Back
British Group	6.51 (1.53)	2.53 (0.9)	115.31 (11.97)	337.1 (71.91)	271.16 (60.78)
Saudi Group	6.94 (1.4)	3 (1)	122 (24.54)	283.38 (59.68)	266.9 (90)

3.3.3.2.3 Accuracy in remembering the focal object.

Repeated mixed ANOVAs were conducted to compare participants' accuracy in remembering focal objects, with cultural groups as the between-subject factor and the four conditions as the within-subject factor. The results showed that there was a significant main effect of culture, $F(1, 31) = 5.28$, p =- .02. The interaction between the four conditions and the cultural groups was also significant, $F(1, 31) = 3.31$, $p < .01$. An independent samples t-test was then performed, with alpha adjusted to 0.013 for multiple comparisons "4 levels". It revealed that Saudi participants ($M = 10.20$, $SD = 1.81$) showed significantly less accuracy in remembering the focal object when it was placed on a new background than the British ($M = 12$, $SD = 1.22$) (t (31) = 3.27, $p = .003$) (Figure 3.6). Ability to recognize previously seen focal objects was also measured by calculating A' using Grier's (1971) equation which incorporates hit and false alarm rates into a single nonparametric measure (Sondgrass & Corwin, 1988). A higher *A′* value indicates greater sensitivity in recognizing old focal objects. For *A′* analysis, we sorted the pictures into two categories of stimuli instead of four: the first was a 'full condition', containing the pictures with previously seen focal/original backgrounds and new focal/new backgrounds, and the second was a 'partial condition', consisting of pictures with previously seen focal/new backgrounds or new focal/original backgrounds. A 2 x 2 mixed ANOVA, with the cultural groups as the between-subject factor and the two conditions of pictures (full/partial) as the within-subject factor, revealed that there was a main effect of condition ($F(1, 32) = 137.22$, $p < .001$), as both groups were more sensitive in recognizing focal objects in full condition than those in partial condition (Table 3.5). The interaction between culture and picture condition was also significant, $F(1, 32) = 4$, $p < .02$. An independent t-test with, alpha adjusted to 0.025 for multiple comparisons, revealed that the difference between the groups was only significant in the partial condition (t (32) = -2.223, $p = .023$), as Saudi participants were less sensitive to recognizing the focal objects than the British. However, the main effect of culture was not significant, $F(1, 32) = 1.624$, $p = .21$. Finally, when we performed an independent t-test on the *A′* values without considering the conditions of the pictures, we found that the British group was more sensitive to recognizing the focal objects ($M = 0.785$, $SD = 1$) than the Saudi group ($M = 0.67$, $SD = 1$) (t (15) = -2.78, $p = .014$).

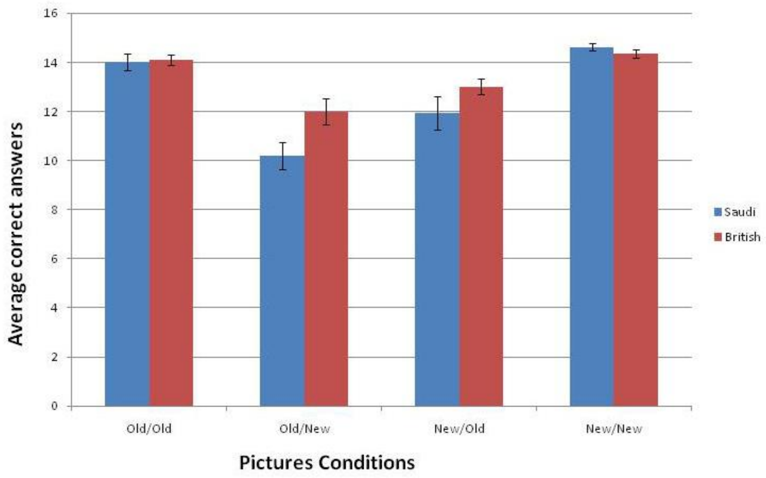


Figure 3.6. Mean number of correct answers for the recognition task in the four conditions for both cultural groups (error bars represent standard errors).

Table 3.5. *A' values for the two conditions in British and Saudi groups, numbers in the parentheses represent SD.*

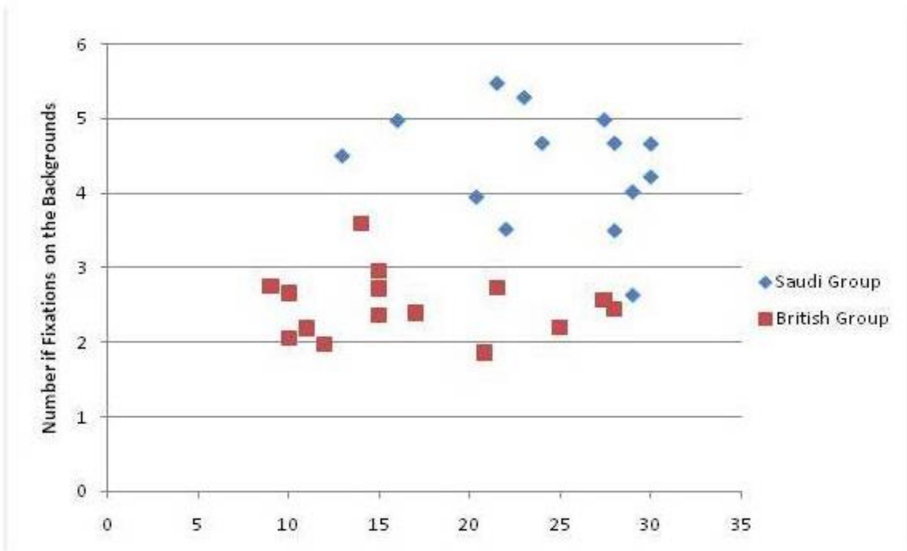
***A'* Analysis**

	Full Condition(M/SD)		Partial Condition(M/SD)	
British Group	0.89	(0.089)	0.72	(0.083)
Saudi Group	0.89	(0.11)	0.63	(0.11)

3.3.3.2.4 Embedded figure test results.

The time an individual spent searching for the simple form in each complex figure was converted into seconds; these figures were totalled, and then divided by the number of figures. The resulting value—the mean search time per item—was the participant's result for the test. Larger numbers reflect greater difficulty in detecting a particular part element embedded within the complex figure. The Saudi group had significantly longer time (*M* = 24.37, *SD* = 5.37) on this test than the British group (*M* = 16.72, *SD* = 6.50) (t (27) = 3.48, $p = .002$). A person product-moment correlation coefficient was calculated to assess the relationship between EFT and the number of fixations on the background and we found a moderate positive correlation between these variables (r (28) = .38, $p < .05$). The same test was conducted to assess the relationship between EFT and the sensitivity to recognizing old focal objects in partial condition. The result revealed a moderate negative correlation between the two variables (r (28)= -.36, n = 17, $p < .05$), meaning that participants they took longer to find the shape in EFT were less sensitive to recognizing old focal objects in partial condition.

The scatter plot in Figure 3.7 shows that the number of fixations on the background tended to be higher for participants who took longer time to find the shape in the EFT. For this reason, and to investigate whether the cultural differences in scene perception are due to differences in cognitive styles (Masuda & Nisbett, 2001; Chua, Boland, & Nisbett., 2005), the data of all participants on this test was divided into two groups using the lower/upper quarters with seven participants in each group (see Table 3.6 for demographics information of each quartile). A mixed repeated ANOVA was then performed to compare the average number of fixations, and average fixation durations with cognitive style groups as the between-subject factor and area of interest as the within-subject factor. In the number of fixations, both groups looked more to the focal area than the background $F(1, 15) = 69.55$, $p < .001$, the main effect of cognitive style was not significant, $F(1, 15) = 3.12$, $p = .098$, however, the interaction between cognitive styles and area of interest was significant [$F(1, 15) = 5.61$, $p < .03$]. An independent t-test revealed that the group with a holistic cognitive style ($M = 4.1$, $SD = 0.75$) looked at the background more frequently than the group with an analytic style ($M = 2.58$, $SD = 0.51$) (t (15) = 4.86, $p < .001$). For the fixation durations, both groups looked longer to the focal area than the background $F(1, 15) = 19.18$, $p = .002$, however, neither the main effect of cognitive style was not significant, $F(1, 15) = 0.09$, $p = .77$, nor the interaction between cognitive styles and area of interest was significant $F(1, 15) = 0.29$, $p = .60$.



Time taken to find embedded shapes in EFT in seconds

Figure 3.7. A scatter plot for EFT findings and number of fixations on the background.

Table 3.6. *Demographics information of each quartile used representing the two cognitive style groups.*

	Cognitive Styles	
	Holistic Style	**Analytic Style**
Culture	7 From Saudi culture	6 from British culture/1 from Saudi
Gender	5 Males/ 2 Females	4 Males/ 3 Females
Average Age	27 years	23 years

An independent samples t-test, with alpha adjusted to 0.012 for multiple comparisons "4 levels", was performed to investigate the accuracy in recognizing focal objects in the four conditions revealed no significant differences between the groups in three conditions (t (15) = 0.70, p = .50 for old pictures, t (15) = -2.25, p = .04 for new focal on original background, and t (15) = 0.20, p = .85 for new pictures). However, the difference for the previously seen focal/new background condition was significant (t (15) = 2.68, p = .02), showing that participants with a holistic style (M = 9.75, SD = 1.91) were less able to accurately remember focal objects when they were placed against new backgrounds than participants with an analytic style (M = 11.89, SD = 1.36).

3.4. Discussion.

The primary aim of the current experiment was to explore cultural differences in scene perception using different cultural group “Saudi” to compare with the Western culture than that was frequently used in the literature “East Asians”, by using two tasks that deemed to explore this difference in different levels without direct attention toward any specific area of the stimuli. By measuring the number of fixations, we found that Saudi participants looked more at the background of natural images than the focal object contained within the scene (Tables 3 and 4). This result supported our hypothesis that Saudi participants would show a greater number of fixations on the background, based on the prediction that the cultural differences in scene perception can be explained by the differences in analytic/holistic style as previous studies have suggested that Saudi individuals tend to adopt a holistic cognitive style (Alaifan, 2009), which also was supported by the participants’ EFT findings in the present experiment as Saudi participants had longer average time to find the embedded figures compared to the British participants. Our results were partly in line with other research that found cultural differences between Westerners and Easterners in their fixation behaviours such as Chua et al. (2005) study, who found that East Asians looked at backgrounds more than Americans. We interpreted these findings on number of fixations as evidence of a cultural difference, as it has been argued that the number of fixations on a particular area reflects the amount of interest in that area (Mackworth & Morandi, 1967, Poole, et al., 2004).

In the present experiment, we found the expected difference between British and Saudi participants only in their responses to the neutral pictures. In addition, British participants had a higher percentage of total gaze durations on the focal objects of pictures from this category than Saudis. A possible explanation for these results could be that most of the neutral pictures contained less interesting objects than did the other categories, as they depicted common scenes which were not related to any specific culture (e.g., a fish in water). In other words, participants' responses to neutral images may better reflect cultural variations, as they hold no specific and strong meanings for the viewer, which could otherwise influence eye movement behaviours (Carniglia, et al., 2012). The results concerning the number of eye movements measured partially support the first hypothesis. However, these results were not clear enough to support the second hypothesis, which was that picture's categories has an influence on eye movement measures. Although we tried to make the pictures in each category as uniform as possible, the Western pictures seemed to have more interesting focal objects, as they had the longest fixation durations for both groups, and both groups took the shortest time to fixate on them. However, the interaction between culture and picture category was only significant in neutral images, possibly for the reason stated above.

Our third hypothesis was that British participants would be more accurate than Saudis in remembering old focal objects on new backgrounds during the recognition phase. Our results show that object recognition performance was less affected by the manipulation of objects and backgrounds (condition three) in British participants than the Saudi group. This result was consistent with previous research in the field (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2006; Goh, Tan & Park ,2009), which found that Westerners were more accurate than Easterners in remembering focal objects on new backgrounds. These results were supported by the results of the A' analysis. Thus, we can conclude that Saudi participants in the present study tended to bind the focal objects with their context in a holistic way of thinking.

As it is frequently posited that cultural differences in scene perception are, in large part, due to the differences between holistic and analytic cognitive styles (e.g., Kitayama, et al., 2003; Masuda & Nisbett, 2001), and to support the explanation provided for the former result, we compared the performance of Saudi and British participants in an EFT. As expected, Saudis showed a tendency toward the holistic cognitive style. Importantly, we were able to almost replicate our main findings on eye movement measures when cognitive style groups replaced cultural groups.

Taken together, the results of the current experiment demonstrate that scene perception is, to some degree, affected by culture. Individuals from Saudi culture tended to blend the focal object with its context: they had a higher number of fixations on the background and a lower percentage of total gaze duration on focal object, and they were more affected by changes in background during the recognition task than the British. Taking the first and second tasks together, we can demonstrate a link between attention given to the focal object in the preference task, and the accuracy at remembering it in the focal recognition task, British participants had longer fixations on the focal objects when they first viewed the stimuli, which could mean that they paid much more attention to the details of the foreground compared to the Saudis. This could explain why they were more accurate at recognizing the focal objects, even on new backgrounds when compared to the Saudi group. The findings of the EFT strongly support the idea that the differences between the analytic and holistic cognitive styles of the two cultural groups are crucial to the aforementioned differences.

3.5 General Discussions and Links Forward

In both experiments, real world photographs with a single focal object were used to investigate the differences between Saudi and British cultural groups. Eye fixations were recorded during performance of the preference task (the task that was used in Experiment 1, as it did not direct attention to any specific area) and during a focal recognition task performed in Experiment 2. The purpose of the latter task was to explore the differences between the two cultural groups in terms of accuracy in deciding whether the focal object had previously been seen, which would reflect the cognitive style encouraged in the observer's culture. Cultures that encourage a larger focus on the most salient object were expected to be less affected by changes accruing in backgrounds.

The results of eye movements in both experiments conducted in the present chapter showed that Saudi participants inspected the background more frequently, indicating that they might allocate more attention to the photograph as a whole. This way of spreading attention appears to weaken the ability for recognising the focal object when it was placed on a new background in Experiment 2, in the second task. The interpretation often proposed to explain these differences is that they are due to the differences in holistic/analytic cognitive styles between cultures; this was supported by the results of EFT. However, caution should be applied to the results of this test, as some of the British participants reported that they were vaguely familiar with the test. From the researcher's experience of this test, being familiar with it makes it easier to discover the embedded figures, even with new stimuli. For this reason and to ensure the validation of its results, this test will be performed in Experiment 3, and again along with other tests that claim to investigate holistic/analytic cognitive styles (see Chapter 6). Identifying the role of culture in the two tasks investigated in this study indicated the robustness of this influence, whether it simply affected how people inspected the scenes, with little or no serious amount of allocated attention, or whether it was strong enough to affect recalling what had been previously seen. In other words, the results pertaining to how accurate recalling the focal object was when changes occurred in the background emphasised the cultural effects that arose in this context.

As a general observation, we noticed that all participants fixated more and for a longer duration on focal objects than on backgrounds. This was to be expected, as focal objects were usually the most informative parts of pictures. This trend was also noticed in the focal recognition phase; this was even more understandable, considering the nature of the task, which specifically directed participants' attention toward the focal objects by asking them to decide whether they were seen before. In addition, this was consistent with the results of most studies examining similar topics (e.g., Chua, Boland, & Nisbett, 2005; Rayner, et al., 2007; Evans, Rotello & Rayner, 2009). Future studies in this area need to follow up on these findings using a different task than the task applied in the current study; for example, research might require participants to inspect photographs in preparation for a memory task. In addition to accuracy performance in the recognition task, eye movement measures in the preparation task will provide an opportunity for investigating the amount of attention allocated by each group to the background.

In conclusion, this chapter discussed the cultural differences arising within scene perception. With the exception of the first analysis in Experiment 1, results in general demonstrated that cultural effects existed to some extent. Based on the findings, the different distributions of eye movements reflected differences in terms of how visual information was processed; this was in turn revealed by the differences in accuracy for recognising the focal objects under the four specified conditions. By using these two tasks, the influence of culture on eye movement behaviours has been supported in a number of studies; however, other important visual tasks are generally overlooked in the field, such as investigating the cultural difference on searching tasks. Goal-driven tasks are needed to be explored in the area of cultural differences in scene perception, as they clearly have a profound effect on guiding visual attention and the distribution of eye movement measures (Chapter 1, section 1.2.1). The aim of the next chapter is to extend the work concerning cultural differences in scene perception in areas to date left nearly unexplored, the type of visual attention required in searching tasks and the means of processing information within a task. These approaches are expected to reveal valuable information about cultural differences in the context of search mechanisms.

Chapter 4: Cultural Differences in Visual Search Tasks

4.1 Visual Search

4.1.1 Visual search and types of stimuli.

Looking for a tomato inside a refrigerator or trying to find a key on a messy desk, are examples of visual search in the real world. It is not an exaggeration when we state that this task is involved in everyday activities, which explains why visual search tasks have been widely studied to provide an insight into attention processing (e.g., Gerhardstein & Rovee-Collier, 2002; Donnelly, et al., 2007; Neider & Zelinsky, 2006). Interestingly, this area appears to have been neglected in the field of cross-cultural differences. Therefore, the main aim of experiments in this chapter was to more closely assess how profound the effect of culture is in scene perception by investigating its influence in a goal-driven task that require individuals to actively scan the visual environment to find a target among other objects. I begin with a short overview about the key methods and assumptions within the visual search literature.

In a typical visual search task, participants are usually instructed to search for an object that is embedded in a cluttered array of objects (distractors), which are positioned on a blank background (e.g., Levin, 1996; Newell, Brown & Findlay, 2004; Zelinsky, 2008). The target object differs in one or more of the low level features. As will be described below, the target can be detected by the parallel process if it differs in one feature. When it is identified by a conjunction of features, parallel processing only helps in restricting the serial search processing of the objects that share a common feature (Wolf, Cave & Franzel, 1989).

Visual search in a scene has been explained by a number of models. Feature integration theory FIT (Treisman & Gelade, 1980) is one of the earliest models that received a great deal of attention. In this model, sensory-based features such as colour, size, and orientation are codded in parallel. If the target differs from its surroundings in one feature, it will pop out at the parallel processing level, and the *search slope* (time spent searching for a target plotted against the number of items) will be independent of those distractors, as they are often called. However, when the target is identified by a conjunction of features, such as looking for a red X among blue Xs and red Vs, the attention is focused on scanning object-by-object, therefore, search slope in this case is a function of the number of objects presented in a stimulus, which is called serial processing. Wolfe (1994) presented an alternative account of the underlying processes, entitled the guided search model (GSM). The model provides two ways of using pre-attentive processing to direct attention to the any target feature, one way is a bottom-up approach, which occurs when the feature of the target is salient, hence, the target pops out. The other way is a top-down approach, which is used when the target and the distractors are sharing one feature; thus, this feature will not be activated based on the bottom-up approach, but based on the knowledge of the task as itself. Top-down effect can also be seen in a likelihood of a target, which is to be in a specific location based on the properties of that target.

A small number of visual search studies have used natural cluttered scenes, with—for instance—a person, an animal, or a car as a target object (e.g., Peelen & Kastner, 2011; Li., et. al., 2002; Thorpe, Fize & Marlot, 1996, LoBue & DeLoache, 2008). The main findings of these experiments revealed rapid detection of the natural scene's target. This particular finding has supported the role of top-down factors on efficient target detection in real-world stimuli, which may indicate the use of a global searching strategy in this type of stimuli (Peelen & Kastner, 2011). Wolfe and his colleagues (2011) provided a new version of GSM to explain visual searching in natural scenes. They called it a dual-path model; some information can be extracted from the scene in one fixation (a global non-selective path), which should effectively guide the selective pathway that basically means selecting individual objects one by one for recognition. In other words, low-level feature in searching for an object in natural scenes is more likely to be coded with other factors such as the semantic guide of the scene itself resulting in ranking the items in the visual field based on their priorities of guiding attention. In the current experiments, real-world photographs were created for the reason stated above, and also because they reveal the concept of *focal and background areas* which have been tested throughout this thesis. The final reason for choosing real-world photographs in the current experiments and in the whole thesis is that they seem to be more ecologically valid compared to other types of stimuli as they have a number of items that are randomly grouped together.

4.1.2 Visual search and eye movements.

As discussed in Chapter 1, section 1.2.2, visual search and eye movements are strongly related, as people usually move their eyes in order to re-position the new regions to adjust the foveal vision. In the visual search task, Findlay & Gilchrist (2003) have suggested that covert attention is supplementing overt eye movements, not substituting for them as it proposed by other researchers. In their review, covert attention is not dissociated from eye movements, but rather, it operates as an integral part of overt attention, and in case of conducting visual search experiments without having any restrictions on eye movements, number of items is effectively monitored in each fixation. The number of items processed is very high if the search is parallel, however, it ranged between 3–10 if the search is serial, and the number of items scanned by a fixation decreased when the target is more complex. Thus, investigating eye movement behaviours is logical in visual search task for several reasons: they indicate the allocation of attention, as people tend to move their eyes unless they instructed otherwise, eye movements are also easier to be monitored and defined using eye tracking technique, moreover, they provide opportunity to enrich RT data.

Recently, an increasing number of visual search studies have taken their research beyond accuracy and RT classical measurements. Advantages for measuring eye movements have included spatial and temporal data, number of fixations, and duration of fixations, which can be used to learn more about the search behaviour. Vlaskamp & Hooge (2006) found that eye movements were directly influenced by the difficulty of search task. When an array was cluttered, the number and the duration of fixations increased. The fixations in another study tended to fall on the objects that shared some similarities with the target object (Williams, Henderson & Zacks, 2005). Fixation patterns were found to support serial and parallel processing in a study conducted by Zelinsky & Sheinberg (1997) as they were measured by simple and conjunctive search stimuli formed by horizontal/vertical and red/green bar targets. The findings of this study demonstrated that the number of fixations increased in conjunctive search condition along with the RT. This measure has also shown to be affected by the purpose of the task in hand, as it varied significantly between a memorizing and searching task (Castelhano, Mack & Henderson, 2009). A number of visual search studies have analysed scanpath in order to gain greater understanding of the search strategies employed by participants (e.g., Locher & Nodine, 1974; Gilchrist & Harvey, 2006). In order to compare two scanpath scores across groups and conditions in the current experiment, we utilised the ScanMatch algorithm (Cristino, et al., 2010) as it takes into account spatial and temporal information, and was previously used to compare the scanpath scores of different groups (Miellet, et al. 2010; Madsen, et al., 2012), See Chapter 2, section 2.3.4 for the description of this method and justifications for choosing it. The main eye movement measures investigated in the current experiments, to provide a good understanding of visual search, are the number and duration of fixations, and the scanpath. It should be noted that the aforementioned studies were conducted using stimuli containing an array of items. However, investigating eye movement data using real-world photographs is necessary, especially when it is suggested that mechanism used for them is different as episodic guidance is operating with this type of stimuli, which includes, the probability of the target presence in a scene, its possible locations, and its relation to other objects in the scene (Wolfe, et al., 2011). In the current experiments we analysed the number of fixations and the duration of fixations before looking at the target as indicators of search efficiency, along with the number of fixations and duration of fixations before generating the key response, RT, and scanpath data.

4.1.3 Cultural differences in visual search.

Visual search is a topic that has received a great deal of attention over the past 30 years; however, the study of cross-cultural variation in visual search is rare at best. As it extensively discussed in Chapter 1, section 1.3, when a person views a scene he/she might preferentially attend to the its focal, or pay more attention to the structure of that scene and the relationships between its parts based on the tendency to process information analytically or holistically. This is how the differences in analytic or holistic cognitive styles have been conceptualized in the field of visual attention (e.g., Chua, Boland, & Nisbett, 2005; Miyamoto, Nisbitt, & Masuda, 2006; Masuda & Nisbitt, 2001; 2006). In order to understand the influence of culture on scene perception we aimed here to extend our previous work by addressing this important question: does culture affect eye movement measures in ecologically-valid search task?

A study conducted by Kuwabara & Smith (2012) on American and Japanese preschool children to test the cultural differences on a visual search task revealed that American children had shorter search time to find the target on a clutter of objects organized as scenes. This was observed in two conditions, both when the stimuli contained more distractors including one coloured distractor object among other elements to make it more salient, and when all objects were in black and white. The shorter RT for American children suggested that their attention might be more focused on the object. However, this difference disappeared when participants from those two cultures performed the same task using artificial stimuli consisting of an array of objects. Another study conducted by Masuda & Nisbett (2006) on the cultural differences in visual search using flicker paradigm in which the original image and a modified one were presented in a sequence with a blank screen presented between each of them. American and East Asian participants were asked to identify the difference between the first and the second images, the differences that they were asked to find were made either to the information related to the focal object or to the contextual information. A planned contrast analysis revealed that while Americans were faster at detecting focal changes, EA participants were faster at detecting contextual changes. On the other hand, Miellet et al., (2010) have investigated cultural differences in the use of extrafoveal information during the visual search of an animal of different sizes in natural scenes using gaze-contingent Blindspot technique, which was either absent (0°), 2°, 5°, or 8° of visual angle and moved contingent to the participant gaze position. They have proposed that due to previous research in this field, East Asians will be better than Western Caucasian participants in the use of extrafoveal information. They have not found any significant differences between the groups in eye movement measures such as number and duration of fixations and RT in all Blindspot conditions, however, they have also calculated matching scores for their subjects by matching the scan paths of each participant with all the other participants of the same cultural group and named it *intra-group*, and calculated *inter-group* matching scores by matching the scan paths of each participant of one group with all the participants of the other group. The ScanMatch analysis revealed significantly lower matching scores in mixed cultures inter-group in the 5° and 8° Blindspot conditions and when a target is absent. They attributed this finding by the impact of culture on exploration strategies just in specific visual constrained conditions, with large central scotomas. Another study, conducted by Rayner et al. (2007), investigated the differences between Chinese and Americans in six different tasks such as scene perception, reading and visual searching task. The visual search task was to find a brown square, which was a part of an array of brown circles, and pink squares. The results displayed that the fixation duration did not significantly differ between the groups. Since the later study used only the duration of fixations, and no further analysis was carried out or reported about the time spent before looking at the targets on one hand, and the lack of studies conducted in this area on the other hand, we believe that the aforementioned studies should not stand alone.

In the previous chapter, we demonstrated some cultural effects in scene perception, utilising preference tasks (Experiment 1) and focal recognition tasks (Experiment 2). It is therefore logical to predict that these cognitive processing may also lead to cultural differences in visual search task that should have more control on eye movements when compared to the previous tasks. Also, based on the review of the literature discussed above, one obvious note is that the cultural effect on scene perception rarely investigated using visual search task, and these studies have revealed heterogeneous results. For that, and to reach a firmer conclusion about the effect of culture in scene perception, we conducted two visual search experiments that have targets either located on the focal or on the background areas, as they will be described in detail in their sections.

4.2 Experiment 3

In Experiment 3, we test whether cultural differences might influence performing a visual search task. Some predictions can be formulated based on the previous research which assumed that Westerners demonstrated greater analytic cognitive style (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001), therefore, it can be predicted that if the British participants pay more attention to the focal area compared to the Saudi participants, the British group would show a shorter RT, with less number and duration of fixations when the target object is placed as a "focal condition." Also it is possible for them to show this pattern in the background's target, if analytic style includes more focused attention to individual object. As it was found that Western participants were better in tasks that required attention to a single object and neglect the surroundings (Kuwabara & Smith, 2012). However, if Saudi participants are more sensitive to the background elements, they might not be less efficient in visual search with the background's target condition. It is also interesting to find out how eye movements and scanpath can be differ when no target is present, as it has been shown that in the target absent case, the behaviour is highly variable depending on one's personal strategies (Miellet, et al., 2010). Another purpose of this experiment is to compare the exploration strategies for both cultural groups by computing the mean matching scores within each cultural group and across groups using ScanMatch method. If the exploration pathways are different between the two cultural groups, then the intra-group scanpath comparisons of Saudi participants and British participants should be bigger than the inter-group scanpath comparison of the Saudi & British participants. This way of measuring ScanMatch scores between groups was previously used in a number of studies, such as a study conducted by Madsen, et al. (2012) who compared mean ScanMatch similarity scores of correct solvers of physics problems to one another, incorrect solvers to one another (I–I), and correct solvers to incorrect solvers. This mean of grouping ScanMatch scores was also similar to that of Miellet et al., 2010 aforementioned study. We therefore suggest that some search strategies may be more common on some cultures than others. Comparing the similarity scores using the ScanMatch method will provide us with an objective tool to meet this aim.

4.2.1 Methodology.

4.2.1.1 Participants.

Thirty-two participants were recruited. Sixteen of them were participants from Saudi (age M = 27.20, SD = 3.43, 6 females) and sixteen were participants from Britain (age M = 20.56, SD = 4.75, 7 females). None of the Saudi participants had lived in the United Kingdom or any other Western countries for more than a year. Participants were recruited by posters and by the Research Participation Scheme system. The British participants were students at the University of Nottingham, some of Saudi participants were PhD students at the University of Nottingham, and some others were students of the English courses conducted by the University. All of the participants had normal or corrected-to-normal vision. They were paid an inconvenience allowance, or earned course credits, and were requested to give their informed consent for the study. The School of Psychology ethics committee approved the protocol.

4.2.1.2 Design.

The experiment used a 2 x 3 mixed design, with a between-subject factor of nationality (Saudi and British groups), and a within-subject factor of stimulus's condition (focal target, background target, and absent target). The dependent variables were: the total number of fixation on the trial, total duration of fixations, RT, and the scanpath in the three conditions of stimuli, the number of fixations before detecting the target and the duration of fixation before detecting the target in the focal/background conditions.

4.2.1.3 Stimuli and apparatus.

Sixty indoor real-world photographs were taken by the researcher using a 10-megapixel Canon Power-Shot E1digital camera, with the size ranging from 60–100 bytes, and were divided into the three conditions. The target item in each stimulus was a piece of fruit, and the location of the fruit was manipulated according to the condition: in the Focal condition, the fruit in the focal area (20 stimuli); in the Background condition, the fruit was located in the background of the scene (20 stimuli), the only difference between stimuli of focal and background fruit conditions was that in the second condition, the fruit was taken further to the background area and one of the background element is brought to the focal area (Figure 4.1). A further 20 stimuli did not contain any fruit and these were used as target absent stimuli. Photographs were set to 900 x 700 pixels and each one was positioned in the center of a white screen. Eye movements were recorded with an SR Research EyeLink II system, with a viewing distance set to 57 cm from the monitor. Participants responded by pressing keys on the keyboard. The experiment was controlled with SR Research Experiment Builder software.

Figure 4.1. Examples of pictures with the fruit as the focal object, and as the background object.

4.2.2 Procedure.

After a calibration procedure, participants were given written instructions and an information sheet. After which they were requested to complete the consent form. Before performing the task, participants were asked to do two practice trials to make sure they understood the goal of the task. They were then asked to respond as quickly as possible by pressing key “1” on the keyboard whenever they detected a fruit in the photograph presented, and press “0” whenever the photograph did not contain a fruit. The photographs under the three conditions appeared randomly. The procedure on each trial was: a screen with the stimulus, which appeared in its centre until the participant made a response; then the drift correction appeared for about 500 ms.

4.2.3 Results.

The statistical analyses were carried out using SPSS, and mainly consisted of 2 x 3 mixed ANOVAs, with cultural groups (Saudi-British) as the between-subject factor and target condition (focal target/background target/absent target) as the within-subject factor. Only correct trials were analysed. Data points that exceeded a cut-off of three standard deviations above or below the mean were removed as outliers, resulting in the loss of 2.46% of the responses. We will first present the average number of fixations and the average duration of fixations. This will be followed by the results of RT in the three target conditions, and the comparisons between the results of EFT and ScanMatch. We will then perform a separate analysis on the 40 images which contained the target on either focal or background locations as a within-subject factor to analyse the average number of fixations, and the average durations before fixating the target for the first time, and also for the last time as looking at the target does not necessarily mean finding it unless it was followed by generating a response.

4.2.4 General eye movement measures and RT on the three conditions.

Firstly, the results of the mean number of fixations will be presented, followed by the mean fixation durations, and finally, the mean reaction time will be presented.

4.2.4.1 Mean number of fixations.

Analysis of the data for correct trials (Table 4.1) revealed an effect of the conditions on the participants $F(2, 58) = 56.97$, $p < .001$, as both groups had more number of fixations when the target was absent, and they had a smaller number of fixations when the target was in the background; however, the smallest number of fixations was in the photographs with a focal target. Pairwise comparisons showed that all of these differences were significant at the .001 levels. The main effect of culture was significant, $F(1, 29) = 14.32$, $p < .001$ as the Saudi group in general had more frequent fixations ($M = 5.75$, $SD = 1.93$) compared to the British ($M = 3.98$, $SD = .89$). In addition, the interaction between the three target conditions and culture was also significant, $F(2, 58) = 9.08$, $p < .001$. An independent t-test with alpha adjusted to .017 for multiple comparisons “3 levels” showed that although the Saudi group in all conditions had higher number of fixations compared to the British group, the difference between the two cultural groups varied according to the target condition, as it is greater in the target absent condition, t (29) = 3.22, $p = .003$ compared to the focal condition t (29) = 3.37, $p = .008$ and to the background condition, t (29) = 5.18, $p = .008$.

Table 4.1.*Mean number of fixations and fixation durations (in ms) in the three conditions for British and Saudi groups, numbers in the parentheses represent SD.*

	Number of Fixations			Duration of Fixations		
	Conditions of the Target					
	Focal	Back	Absent	Focal	Back	Absent
British Group	3.13 (.60)	3.51 (.59)	5.28 (1.48)	262.51 (47.57)	255.56 (61.13)	241.53 (42)
Saudi Group	3.44 (.91)	4.51 (1.21)	8.81 (3.66)	255.17 (47)	256.12 (40.22)	240.74 (29.76)

4.2.4.2 Mean duration of fixations.

The main effect of target conditions showed an effect on both cultural groups (see Table. 4.1), $F(1, 29) = 7.68$, $p = .001$. However, pairwise comparisons revealed that the only significant difference between the durations on these conditions was between the average duration on the focal target condition compared to the absent target condition, $p = .002$. Neither the main effect of culture, $F(1, 29) = 1.63$, $p =$

.21, nor the interaction between culture and the target conditions, *F(*1, 29) = .51, *p* = .48, was significant.

4.2.4.3 Mean reaction time.

For the mean reaction time for only correct trials, the results (Figure 4.2) showed that there was an effect of the target condition *F(*2, 58) = 46.22, *p < .001*, as both groups had a longer reaction time when the target was absent (*M* = 1613.83, *SD* = 836.46), than when the target was in the background (*M* = 923.36, *SD* = 328.70), and the shortest RT was in the photographs with a focal target (*M* = 816.89, *SD* = 264.03). The main effect of culture was significant, *F(*1, 29) = 11.14, *p < .003* as the Saudi participants in general had a longer RT (*M* = 1347.76, *SD* = 527.117) compared to the British (*M* = 902.65, *SD* = 294.23). In addition, the interaction between the three target conditions and culture was also significant, *F(*2, 58) = 8.75, *p < .001*. An independent t-test with alpha adjusted to .017 for multiple comparisons "3 levels" displayed that the only significant difference between the two groups was on the target absent condition, t (29) = 3.45, *p* = .002 as the Saudi group took longer RT (*M* = 2069.68, *SD* = 924.92) compared to the British group (*M* = 1186.47, *SD* = 445.29). Finally, it should be noted that the accuracy was measured as per the number of photographs, which were correctly identified as "target present" or "target absent," and both groups performed with equal high accuracy, *M* = 97.65%, *SD* = 1 for Saudi group, and *M* = 99.57%, *SD* = 1.03 for British group.

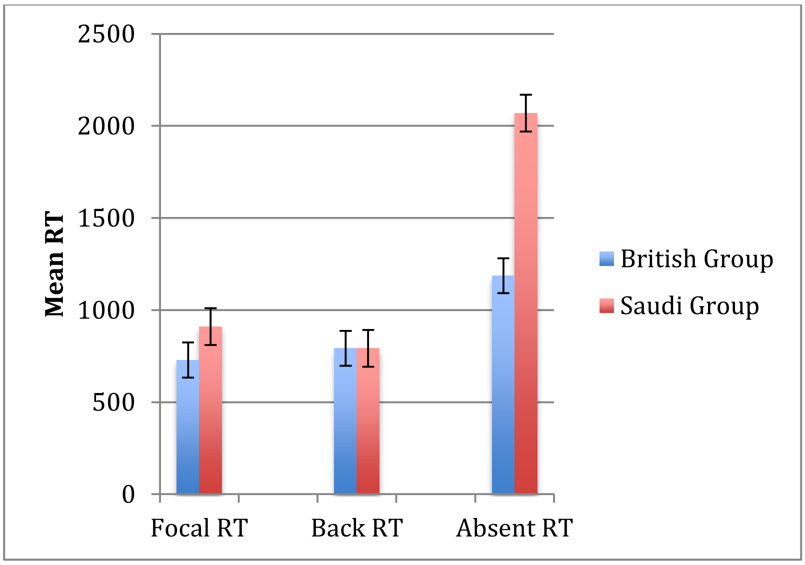


Figure 4.2. Mean of reaction time (RT) in the three conditions for British and Saudi groups.

4.3 Scanpath Analyses

In section 2.3.4 of Chapter 2, the ScanMatch technique for quantifying the sequence of fixations and the arrangement of data was described. As outlined earlier in this chapter, this way of grouping the ScanMatch scores was previously adopted (Miellet, et al., 2010; Madsen, et al., 2012). We divided participants into three main comparison groups, 1) intra-group scanpath comparison of Saudi subjects "S_S," which compares the scores of each Saudi participant with each participant of his/her cultural group; 2) intra-group scanpath comparison of British subjects "B–B," which compared the score of each British participant for identical stimuli with each participant of his/her cultural group; and 3) inter-group "S–B" comparison, which compared the score of each participant from one cultural group with each participant of the other cultural group, as in our case, each Saudi participant with each British participant (see Appendix B). This analysis provides a mean to directly compare the exploration strategies for each cultural group, if these strategies are different, then the mixed cultural comparison group (S–B) should have the smallest matching scores.

A one-way ANOVA was conducted to compare the ScanMatch scores for the S–S, B–B, and S–B comparison of groups for each target condition. Table 4.2 represents the mean scores for these comparison groups. The analyses revealed a main effect of comparisons in each of the three target conditions, [$F(2, 464) = 50.98$, $p <.001$, $F(2, 464) = 22.35$, $p < .001$, $F(2, 464) = 21.69$, $p < .001$] for the focal, background, and target absent conditions respectively. The contrast revealed that, as a general finding, the B–B comparison group had statistically higher ScanMatch score than the other two comparison groups in the three conditions. In the focal target condition, this group had a higher score than the S–S comparison group, $t(210.41) = -10.61$, $p < .001$, and also a higher score than the S–B comparison group $t(301.41) = 8.75$, $p < .001$. For the background target condition, B–B comparison group also had the higher ScanMatch score than the S–S comparison group, $t(207.25) = -6.64$, $p < .001$, and a higher score than the S–B comparison group $t(290.84) = -5.99$, $p < .001$. Finally, for the target absent condition, B–B comparison group had the higher ScanMatch score than the S–S comparison group, $t(223.15) = -6$, $p < .001$, and S–B comparison group $t(261.74) = -6.1$, $p < .001$. Only, in the focal target condition, S–S comparison group had statistically lower ScanMatch score than S–B comparison group, $t(229.84) = -3.1$, $p = .002$, other than that, no significant differences between the S–S and S–B comparison groups were found (Appendix C).

Table 4.2.

Means of ScanMatch scores in the three types of differences for S–S, B–B, and S–B comparisons, numbers in the parentheses represent SD.

Types of Comparisons	Conditions		
	Focal	Background	Absent
S-S	.55	.53	.38
	(.07)	(.08)	(.05)
B-B	.64	.60	.42
	(.06)	(.07)	(.06)
S-B	.57	.55	.38
	(.08)	(.08)	(.07)

4.3.1 Eye movements on the focal/background targets.

4.3.1.1 Mean number of fixations.

Mean number of fixations and average fixation durations before the first fixation, and before the last fixation on the focal and the background targets were subject to a 2 x 2 mixed design ANOVA with cultural groups as a between-subject factor, and the location of the target (focal/background) as a within-subject factor. The results are presented in Table 4.3. Both cultural groups had a main effect of target condition, as they have a smaller number of fixations before looking for the first time at the focal target compared to the targets which were located in the background, $F(1, 29) = 21.22$, $p < .001$. However, neither the main effect of culture, $F(1, 29) = 3.1$, $p = .09$ nor the interaction between culture and the location of the target $F(1, 29) = .784$, $p = .38$ was significant. Both cultural groups had a smaller number of fixations before viewing the focal target for the last time compared to those before the targets that were located in the background $F(1, 29) = 15.36$, $p < .001$. However, neither the main effect of culture, $F(1, 29) = 1.63$, $p = .21$ nor the interaction between culture and the location of the target $F(1, 29) = .51$, $p = .48$ were significant.

Table 4.3. *Means of number of fixations and fixation durations (in ms) before first and last fixation on the foreground and background targets for British and Saudi groups, numbers in the parentheses represent SD.*

	Number of fixations (first/last)				Duration of fixations (first/last)			
	Focal	Back	Focal	Back	Focal	Back	Focal	Back
British Group	1.60 (.39)	2.13 (.45)	2.14 (.50)	2.87 (1.19)	221.25 (41.50)	215.50 (57.56)	217.15 (39.66)	214.04 (58.97)
Saudi Group	1.86 (.37)	2.64 (1.29)	2.61 (.84)	3.11 (.90)	195.16 (39.46)	186.69 (33.83)	200.86 (36.50)	191.90 (30.34)

4.3.1.2 Mean duration of fixations.

In this measure, no main effect of target condition was obtained as both groups did not show any significant differences in the duration of fixations before looking for the first time to the focal and to the background targets, $F(1, 29) = 3.50$, $p = .07$. In addition, none of the other effects were significant, $F(1, 29) = 3.17$, $p = .09$ for the main effect of culture, and, $F(1, 29) = .14$, $p = .71$ for the interaction between culture and the target condition.

Similar to the previous results, the main effect of target condition was not significant, both groups did not demonstrate any significant differences in the duration of fixations before looking for the last time at the focal and background targets, $F(1, 29) = 1.67$, $p = .21$. Additionally, neither the main effect of culture, $F(1, 29) = 1.80$, $p = .19$, nor the interaction between culture and the condition of the target was significant, $F(1, 29) = .39$, $p = .54$ (Table 4.3).

4.4 Discussion

The current experiment aimed to find out whether eye movement behaviours in visual searching task would reflect cultural differences, and whether the scanpaths of each cultural group would show a higher degree of similarity when compared to the mixed cultural comparison. The results of the average number of fixations and the average durations before detecting the targets for the first and for the last times did not reveal any significant differences between the Saudi and British groups. This might be related to the difficulty level of the task, as the targets could be found with only little effort.

Number of fixations in search task known to reflects its condition, and difficulty (e.g., Korner, Gilchrist, 2008; Vlaskamp & Hooge, 2006), for that, the higher overall average number of fixations, and the longer RT for Saudi participants suggested that they may found this task to be more difficult than the British participants when trying to find the target. This finding is consistent with the longer RT in general, which in turn indicates less efficient search. The RT findings are consistent with the Kuwabara & Smith (2012) study, which found that U.S. children had shorter RTs compared to Japanese regardless of the task condition. In other words, the obtained differences could be related to the preference of cognitive styles, as being more analytic might mean a greater ability to focus on the task at hand. The longer RT for the absent target condition, which was the case for both the Saudi and the British groups were consistent with previous research (e.g., Gilchrist & Harvey, 2006), and with the fact that it has been found that in visual search task, the manual

RT for target absent condition is about 4.200 ms as opposed to 2.205 ms for target present condition (Korner, Gilchrist, 2008).

A further confirmation of cultural differences in the current experiment can be derived from ScanMatch findings, as S–S comparison group displayed a smaller score than that of B–B comparison group. Smaller similarity scores means less similar scanpath among this group, which possibly was an indication of the size of variety inside Saudi group in their general searching strategies. It should be noted that by examining means at Table 4.2, one can conclude that the presence of the targets played a dominant role in maintaining the similarities in search strategies, as similarity scores for all groups went down on target absent condition, this is particular true regarding S–S comparison group.

Finally, although some findings such as, number of fixations, RT, and ScanMatch analysis reveal cultural differences on visual search task, other eye movement measures did not, such as the fixations before detecting the target for the first and the last time. This might be because “fruits” are an easy object to be detected, especially in the focal target condition, which may leave a little room for good eye movement data to be obtained. If this were the case, one would expect more valuable information about fixations data when using more complex search task such as the one that was adopted in the next experiment. Experiment 4 aimed to take the visual search task conducted in this experiment a step further by increasing its difficulty level using a comparative visual search (CVS) and assessing how this change might influence eye movement measures.

4.5 Experiment 4

To address the question of the effect of culture on eye movements in a visual search task that has more complexity than the previous one, a typical CVS task consists of pairs of identical images presented side by side with one object, which mismatches with its corresponding object in color, size, position or any other feature. The task basically is to search for one difference between the two images on display and detect the mismatch (e.g. Pomplun, Reingold & Shen, 2001). Generating a mouse button or a key from a keyboard is usually adopted to identify the detection of the target, however, in the current experiment; the instruction was to keep the finger on a specific key and keep fixating on the target when found in the left hand image, and pressing the key to be more certain that they really found it.

There are two main reasons for conducting a (CVS) task to further test cultural differences in the area of visual search. The first reason is related to the results of Experiment 3, since there were a small number of fixations in general, and particularly on the focal target condition. The data suggested that the target might pop out very quickly before any effort was made. This validates conducting a CVS as a reasonable extension of that experiment. Moreover, the use of memory in these two tasks significantly differ, which may reveal valuable results, as the usage of the memory in the CVS task is more complex and difficult. Based on Pomplun, Reingold & Shen (2001) the standard visual search task requires remembering a representation of a single target, while in the CVS task the participants are required to keep two sets of items in mind at the same time, which means there is more load on the working memory. By increasing the task difficulty and the use of working memory, it can be predicted that scanning and encoding items that located on the focal or background areas can be affected by culture, in specific the tendency to process visual information in analytic or holistic styles. Thus, a comparison between eye movement behaviours and RT in visual search task and a comparative visual search task may present a valuable opportunity to reach a firmer conclusion about cultural differences in scene perception.

Another reason for choosing this paradigm is because it has been found that the central changes, which were more visually salient, are less easily detected in CVS task than other tasks, such as change blindness paradigm, even with the same stimuli, which may suggest that the CVS task is guided by the meaning of the scene more than by visual saliency (Klein & Shore, 2000). This is highly important in our case, as the main theme in the current thesis was to investigate the differences in visual perception between the Saudi and the British cultures in the focal/ background areas, which makes more sense to choose a paradigm that has less central advantage.

As far as we can determine, no research regarding cultural differences in this specific task has been conducted, however, based on the findings obtained from our previous experiment, we can predict that the Saudi participants would tend to show a longer RT and more number of fixations compared to the British. In addition, if searching strategies considerably vary in Saudi sample as the results of ScanMatch in Experiment 3 have suggested, we would expect a similar findings pattern in ScanMatch result.

4.5.1 Methodology.

4.5.1.1 Participants.

Thirty British participants (age M = 21.35, SD = 2.96, 17 females) and thirty Saudi participants (age M = 24.16, SD = 2.79, 16 females) from the University of Nottingham were recruited for this experiment by poster and paid £3 or given 0.5 credit for participation. All had normal or corrected-to-normal vision.

4.5.1.2 Design.

The experiment used a 2 x 2 x 3 repeated measures mixed ANOVA with a between-subject factor of nationality (Saudi and British groups), and within-subject factors of stimulus (focal and background targets), and the three types of changes (deleting, substituting, and changing the orientation). The independent variables were: cultural groups; the target area of interest (focal and background); and the three types of changes (deleting, substituting, and changing the orientation). The dependent variables were: the average number of fixations, and the average durations before fixating the target for the first time, and before fixating the target for the last time, general reaction times, and the scanpath of the focal and background targets.

4.5.1.3 Stimuli.

Sixty-six images were created for this experiment, which consisted of two real-world photographs arranged side by side on a white background. The distance between the edges of each image was set to 3.50 cm. The contents in the stimuli were kitchen appliances, office desks, and bathroom accessories. The photographs in each pair differed in one of the targets that were placed either on the focal area (33) or in the background (33), with a distance set to 18.6 cm between the target and its correspondent. The size of the images was set to 672.76 x 869.29. In order to differentiate the photographs, the change was made by physically changing the object in one photograph either by *target deletion* as one object which was present in the right-hand photographs was absent in the left-hand, *target re-orientation* as one object which was present in the right-hand image was rotated in the left-hand image, or finally by *target substitution* as one object which was present in the right-hand image was substituted for another object which appeared similar to the original one in the size. Examples for orientation focal/background differences are presented in Figure 4.3.

Figure 4.3. Two examples of stimuli: the top pair represents focal orientation difference; the bottom pair represents background orientation difference.

4.5.1.4 Apparatus.

Eye movements were recorded with an SR Research EyeLink II system, with a viewing distance set to 57 cm from the monitor. Participants responded by pressing keys on a keyboard. The experiment was controlled with SR Research Experiment Builder software.

4.5.2 Procedure.

After a calibration procedure, participants were instructed to search for the difference between the pair of images as quickly as possible. They were informed that each trial contains one difference, when they find it; they should keep fixating on it "stare at the different object on the left hand image", and press a specific key on the computer keyboard. Thus, any trial with no last fixation on that specific area in the left-hand image would be considered an error, as if the participant did not actually detect the difference. Participants were not informed of the possible locations of the difference or the types of differences they would be searching for. After six practice trials, the experiment began. Each trial started with a central fixation point on a white background for 500 ms, this was replaced by the photograph screen, and participants were free to inspect it for as long as they needed until they decided to press the key, when they did that without looking at the left-hand target, they were reminded to do so on the remaining trials. The sequence of the focal and background differences was randomized for each participant. The whole experiment took approximately 20–25 minutes to complete.

4.5.3 Results.

The data from two Saudi participants were excluded from analysis due to poor calibration. The statistical analyses were carried out using SPSS, and mainly consisted of 2 x 2 x 3 mixed design ANOVAs, with cultural groups (Saudi-British) as the between-subject factor and the location of the target (focal-background) and the three types of changes (deleting, substituting, and changing the orientation) as within-subject factors. Data points that exceeded a cut-off of three standard deviations above or below the mean were removed as outliers, resulting in the loss of 1.74% of the responses. First, we will present the results of the mean number and duration of fixations before looking at the target, which positioned in the left-hand images for the first time and for the last time, after which, the general RT and ScanMatch comparison results will be presented.

4.5.4 Analysis of eye movement before looking to the targets.

4.5.4.1 Mean number of fixations.

The mean number of fixations before fixating the target for the first time for correct trials is presented in Table 4.4. For both groups, the main effect of target location was significant, as the average number of fixations before fixating the focal target in all types of changes was smaller than those before the background target, $F(1, 56) = 179.65$, $p < .001$. The results showed a main effect of culture $F(1, 56) = 6.20$, $p < 0.05$, as Saudi group had a higher number of fixations ($M = 8.70$, $SD = 4$) compared to the British group ($M = 6.52$, $SD = 3.51$). However, the interaction between target's location "focal/background" and culture was not significant $F(1, 56) = 2.59$, $p = .11$. The effect of the three types of changes was significant $F(2, 112) = 4.36$, $p = .02$, pairwise comparisons displayed the number of fixations before fixating the target for the first time in substitution change ($M = 7$, $SD = 3.47$) was significantly smaller than the other two types of changes ($M = 7.93$, $SD = 3.56$), $p < .001$ for deletion change and ($M = 7.79$, $SD = 4.73$), $p < .001$ for changing the orientation. On the other hand, the interaction between the types of changes and culture was not significant, $F(2, 112) = .24$, $p = .79$. The interaction between the location of target "focal/background" and the three types of changes was significant $F(2, 112) = 4.22$, $p = .02$. The substitution change received the smallest number of fixations before viewing the target when it was in the background ($M = 8.60$, $SD = 3.76$) compared to the other types of differences ($M = 9.75$, $SD = 5.44$ for changing the orientation and $M = 10$, $SD = 3.97$ for deletion change). The interaction between target's location, three types of differences and culture was insignificant $F(2, 112) = 2.72$, $p = .07$.

Table 4.4. *Mean number of fixations before fixating the focal/background targets for the first time for British and Saudi groups in the three conditions on the target on the left-hand image, numbers in the parentheses represent SD.*

Changing Types	**D* (M/SD)**		**S** (M/SD)**		**O*** (M/SD)**	
Target Location	**Focal**	**Back**	**Focal**	**Back**	**Focal**	**Back**
British Group	4.61 (2.93)	8.98 (3.90)	4.91 (2.72)	7.37 (2.84)	5.13 (3.70)	8.12 (4.97)
Saudi Group	7 (2.91)	11.14 (3.80)	5.33 (3.52)	9.83 (4.23)	6.51 (4.31)	11.38 (5.50)

The mean number of fixations before fixating the target for the last time for correct trials is presented in Table 4.5. For both the groups, target location have an effect as the average number of fixations before fixating the focal target in all types of changes was smaller than those before the background target, $F(1, 56) = 137.32$, $p < .001$. In addition, the results showed a main effect of culture $F(1, 56) = 11.76$, $p = .002$, as Saudi group had a higher number of fixations ($M = 11.65$, $SD = 4.28$) compared to the British group ($M = 9.33$, $SD = 2.86$). However, the interaction between target's location and culture were not significant $F(1, 56) = 0, 00$, $p = 1$. The effect of the three types of changes was significant $F(2, 112) = 12.36$, $p < .001$, pairwise comparisons showed a significant difference between the number of fixations before fixating the target for the last time in changing the orientation (*M* =

11.60, $SD = 4.44$), compared to the other two types of changes ($M = 10.13$, $SD = 3.24$), $p < .001$ for deletion and ($M = 9.73$, $SD = 3.78$), $p < .001$ for substitution change. The interaction between the target location and the types of changes was significant $F(2, 112) = 7.71$, $p = .002$, as changing the orientation received significantly more fixations when it was placed in the background ($M = 14.41$, $SD = 5.85$) compared to the other two types of changes ($M = 12.86$, $SD = 3.64$), $p < .001$ for deletion and ($M = 11.35$, $SD = 3.92$), $p < .001$ for substitution. On the other hand, the interaction between the types of changes and culture was not significant $F(2, 112) = 0.183$, $p = .83$. Also, the interaction between target's location, three types of changes, and culture was not significant $F(2, 112) = 1$, $p = .26$.

Table 4.5. *Mean number of fixations before fixating the focal/background targets for the last time for British and Saudi groups in the three conditions on the target on the left-hand image, numbers in the parentheses represent SD.*

Changing Types	**D (M/SD)**		**S (M/SD)**		**O (M/SD)**	
Target Location	**Focal**	**Back**	**Focal**	**Back**	**Focal**	**Back**
British Group	6.15 (1.34)	12 (3.95)	6.80 (2)	10.11 (3)	7.88 (2.15)	12.98 (4.71)
Saudi Group	8.67 (3.43)	13.67 (3.14)	9.43 (4.46)	12.59 (4.41)	9.71 (3.91)	15.84 (6.32)

4.5.4.2 *Mean duration of fixations.*

The mean duration of fixations before fixating the target for the first time for correct trials is presented in Table 4.6. For both groups, there was a main effect of target location, as the average duration of fixations before fixating the focal target in all types of changes was shorter than those before the background target, $F(1, 56) = 6.84$, $p = .02$. However, neither the main effect of the culture $F(1, 56) = 2.17$, $p = .15$, nor the interaction between target's location and culture were significant $F(1, 56) = 0.76$, $p = .39$. In addition, neither the effect of the three types of changes $F(2, 112) = 2.99$, $p = .06$, nor the interaction between the three types of changes and culture were significant $F(2, 112) = 0.12$, $p < .89$. Also, the interaction between the location of target and the three types of changes was not significant $F(2, 112) = 1.69$, $p = .19$. Finally, the interaction between target's location, three types of changes, and culture was not significant, $F(2, 112) = 0.36$, $p = .70$.

Table 4.6. *Mean duration of fixations before fixating the focal/background targets for the first time for British and Saudi groups in the three conditions on the target on the left-hand image, numbers in the parentheses represent SD.*

Changing Types	**D (M/SD)**		**S (M/SD)**		**O (M/SD)**	
Target Location	**Focal**	**Back**	**Focal**	**Back**	**Focal**	**Back**
British Group	211.68 (31.28)	215.48 (29.37)	209.47 (30.22)	209.89 (24.81)	210.42 (32.61)	214.27 (28.1)
Saudi Group	200.94 (22.59)	210.63 (25)	199.95 (22.1)	200.93 (19.87)	200.12 (19.35)	205.60 (21.13)

The mean duration of fixations before fixating the target for the last time for correct trials is presented in Table 4.7. There was no main effect of target location, as results revealed no significant difference between the average duration of fixations before fixating the focal and the background targets, $F(1, 56) = 0.130$, $p = .7$. In addition, there was no effect of culture $F(1, 56) = 0.98$, $p = .34$, and no interaction between location and culture $F(1, 56) = 0.60$, $p = .4$. The effect of the three types of changes was significant $F(2, 112) = 5.40$, $p = .006$, pairwise comparisons showed a significant difference between duration of fixations before fixating the target "or the location of the target" for the last time in target deletion (*M* = 211.96, *SD* = 26.60), compared to the changing the orientation, (*M* = 207.91, *SD* = 24.63), $p < .001$ and target substitution (*M* = 206.79, *SD* = 24.05) $p < .001$. The interaction between the types of changes and culture was not significant $F(2, 112) = 0.48$, $p = .62$. Also, the interaction between the location of target and the three types of changes was insignificant $F(2, 112) = 2.94$, $p = .06$. The interaction between target's location, three types of changes, and culture was not significant, $F(2, 112) =1.13$, $p = .33$.

Table 4.7.*Mean duration of fixations before fixating the focal/background targets for the last time for British and Saudi groups in the three conditions on the target on the left-hand image, numbers in the parentheses represent SD.*

Changing Types	**D (M/SD)**		**S (M/SD)**		**O (M/SD)**	
Target Location	**Focal**	**Back**	**Focal**	**Back**	**Focal**	**Back**
British Group	215.74 (24.40)	213.28 (27.47)	211.23 (25)	207 (21.64)	210.76 (25.79)	212.88 (26.42)
Saudi Group	206.78 (27.89)	212 (26.79)	207.46 (25.61)	201.96 (24.29)	202.96 (22.82)	205.36 (22.67)

Finally, we tested the time spent between fixating the target for the first time and for the last time in the left-hand image. If the target was detected at the first sight, the time between these two measures should be 0. For both groups, the average additional search time was shorter with focal targets (*M* = 1011.23, *SD* = 579.22) compared to the target on the background (*M* = 2465.4, *SD* =1171.64), [$F(1, 58) = 8.14$, $p = .007$], the main effect of culture was significant, $F(1, 58) = 4.96$, $p = .04$, as Saudi participants in general had a longer additional search time (*M* = 1568.68, *SD* = 1302.50) compared to the British (*M* = 1050.60, *SD* = 427.25), however, no interaction between the target location and culture was found in this measure, $F(1, 58) = 1$, $p = .3$.

4.5.4.3 Mean reaction time.

For the mean reaction time for correct trials, the results showed that there was a main effect of the target location $F(1, 56) = 227.50$, $p < .001$, as both the groups had shorter reaction time when the target was in the focal area (*M* = 5261.71, *SD* = 2033.21), than when it was in the background (*M* = 8958.44, *SD* = 2522.19). The main effect of culture was significant $F(1, 56) = 10.55$, $p < .003$ as Saudi participants in general had a longer RT (*M* = 7928.47, *SD* = 2833.27) compared to the British (*M* = 6291.17, *SD* = 1192.95). However, the interaction between the location of the target and culture was not significant $F(1, 56) = 8.75$, $p = .33$. Finally, as mentioned in the procedure section, participants were asked to stare at the target on the left-hand image to study accuracy, which was measured by the location of the last fixation. If it was around the target's area on the left-hand image, a participant is considered to be accurate, however, when a participant had 7.57 % of the trials (i.e., five images) with incorrect location of the last fixation, he/she was considered as inaccurate. With the exception of two Saudi participants, who had poor calibration procedures, both groups performed with equal high accuracy, *M* = 94. 25%, *SD* = 1.05 for Saudi group, and *M* = 96.20%, *SD* = 1.19 for British group.

4.5.5 Scanpath result.

A one-way ANOVA was conducted to compare the ScanMatch scores for the S–S, B–B, & S–B comparison groups for the focal and the background targets. Table 4.8 represents the mean scores for these comparisons. ANOVA statistically demonstrated the main effect of comparisons in the 2 target locations [$F(2, 1548) = 65.98$, $p < .001$, $F(2, 1548) = 23.33$, $p < .001$] for the focal and the background targets respectively. The contrast revealed that the B–B comparison had statistically higher ScanMatch score in the two target locations. In focal target condition, this group had a higher score than the S–S comparison group, t (424.01) = -10.104, $p < .001$, and also a higher score than the S–B comparison group t (1224.449) = 12.01, $p < .001$. Similar results were found for the background target, B–B comparison group had the higher ScanMatch score than the S–S comparison, t (455.16) = -5.81, $p < .001$, and a higher than the S–B comparison group t (1216.227) = 7.36, $p < .001$.

(An example of the ScanMatch of a Saudi participant and a British participant was provided in appendix D)

Table 4.8. *Mean of ScanMatch scores in the two target locations for S–S, B–B, and S–B comparisons, numbers in the parentheses represent SD.*

Types of Comparisons	Target locations	
	Focal	Background
S-S	0.47	.047
	(0.07)	(0.05)
B-B	0.51	0.49
	(0.04)	(0.02)
S-B	0.48	0.47
	(0.06)	(0.05)

4.6 Discussion

The aim of this experiment was to further test cultural difference in visual search task that was more complex than that of Experiment 3, the general pattern of results in present experiment is in agreement with those in Experiment 3. Again, scanpath analyses revealed that the B–B comparison group tended to show higher similar ScanMatch scores, when compared to B–S, S–S comparison groups, suggesting that the British participants might tend to inspect stimuli using similar exploration and searching strategies compared to the Saudi participants, who in turn seems to have more variety in their exploration pathways.

A further finding of interest concerns the number of fixations. The larger average number of fixations for the Saudi group, which was also observed in Experiment 3 may be a result of a difficulty in finding the target, and a slower key response, especially when noting that this difference appeared as soon as the participants fixated on the target for the first time, as the greater number of fixations indicate less efficient search (Goldberg & Kotval, 1999). This may also indicate that they tend to display different searching strategies than the British, while the British participants, and based on their smaller number of fixations, may have found this task easier, based on the relationships described between the search difficulty and number of items processed per fixation (Findlay & Gilchrist, 2003). These findings, in general, may indicate that the British participants displayed an object-by-object searching strategy to detect the changes, which had been previously found (Galpin & Underwood, 2005), among British participants. An object-by-object searching strategy for British participants could also explain the fact that they had a higher similarity scores in the ScanMatch comparison analysis.

Another explanation for this finding could be related to degree of commitment to the task at hand, British participants may be more task orientated compared to the Saudi subjects who may be more distracted by the structure of the scenes. Although the literature related to the task orientation across cultures is extremely rare, the tendency for western individuals to demonstrate a more focused task orientation was found in a previous study, where Swedish participants took a shorter time to solve a 54-piece puzzle compared to the Greeks (Audickas, Davis & Szczepańska, 2006). In terms of the reaction time measure, the overall pattern of RT and eye movement data for correct trials suggested that the British group was generally more efficient in visual searching than the Saudi group, regardless of the target's location. These findings may indicate that analytic cognitive processing provides more capacity for focused attention on the individual objects, an advantage of being more able to direct attention towards task goals.

Two further findings were observed for both groups: first, a tendency to find focal differences more easily than those positioned in the background, as both groups had shorter RT, and smaller number of fixations in detecting focal changes, which is expectedly based on the central tendency bias (Tatler, 2007; Zelinsky, et al., 1997). This finding was also in agreement with Rensink's (1997) conclusion that people are likely to detect changes in center and focal areas faster than the changes in peripheral or background areas. Second, substituting the target with a new similar target seemed to be the easiest difference, while changing the orientation tended to be the hardest based on the RT and the number of fixation results. We are unable to demonstrate a reliable conclusion on that, as we cannot fully claim that objective means were used to be certain of their characteristic equivalence in their difficulty level.

4.7 General Discussion and Links Forward

The experiments in the current chapter aimed to investigate cultural differences in visual search task as an extension of our experiments in Chapter 3 that have used basic visual less complex tasks. However, based on the very small number of studies that have been conducted to investigate cultural variation in visual search task, and on the idea that different cognitive styles are adopted in the two cultures investigated here, which seems to alter the way that people inspect scenes, it was predicted that differences in searching strategies could appear here.

Two different visual search tasks were chosen: searching for a " a piece of a fruit" in real world pictures and a comparative visual search. Three main significant differences between Saudi and British groups were found: Saudi participants made more fixations on stimuli, and took generally longer RT to find the target/ mismatch. Finally, the similarity score for S–S group was not significantly different than the mixed group, on the other hand, the score of B–B group was significantly higher than those of the other two groups which is consistent with previous study (Miellet, et al., 2010), and suggested that British participants used more similar exploration and search strategies. The greater number of fixations for Saudi group may be a result of finding these tasks to be more difficult than how British participants did perceive them, or to be less task orientated compared to the British group. These results along with the longer RT and the longer time spent between looking at the target for the first time and for the last time, which measured in Experiment 4 could be an indication of Saudi participants being less efficient in visual searching task regardless of the location of the target. Longer searching time was previously observed with participants from collectivistic cultures (Kuwabara & Smith, 2012; Masuda & Nisbett, 2006), although the later study found this pattern only for focal changes, and they found the opposite pattern for contextual changes.

Our obtained findings may indicate that analytic cognitive processing provide more capacity for focused attention on individual object, as individuals with a tendency to analytic cognitive style may be less affected by the surrounding information in the scene when scanning items to search for the target compared to those with a tendency to holistic style. This explanation is also in line with a number of experiments, which found that people with local "analytic" processing perform better in finding the Navon-like shape, the one that shares one similarity with the target shape, when compared to those with lesser local tendency and attributed this advantage by ability for individuals with local processing to focus on the task at hand and be less distracted by the surrounding (Davidoff, Fonteneau, & Fagot, 2008; Carparos, et al. 2012). If the obtained differences were due to the greater ability to control visual search to be focused on the target in order to meet the goal in hand for individuals with analytic cognitive style, future research can test this by using visual search tasks with possible analytic and holistic cognitive advantage.

In summary, our general findings in the current chapter such as number of fixation, RTs, and ScanMatch analysis revealed that some cultural differences do exist in more demanding tasks such as visual searching task, which indicates the amount of influence cultural factors have in the field of scene perception. Although some of these findings have not agreed with a number of previous research such as the non-significant differences in the number of fixations between Westerners and Easterners in Miellet et al., (2010) study, and the shorter searching time for Easterners to find contextual changes compared to the Americans "Masuda & Nisbett, 2006), visual stimuli and methodological differences across these studies could account for the contrasting findings.

Our main findings provide some evidence for considering visual search tasks as a way that could reveal rich information about cultural differences in this particular field. However, the questions of how culture affects searching strategies, and which particular factors in culture are in play, are still open for many studies to come. If the role of culture is well understood, it could have a significant influence on computational modelling of eye movement behaviours. The question which remains unresolved is which aspects of the culture lead certain societies to adapt different means to inspect scenes and using searching strategies. As discussed in Chapter 1, section 1.3.2 a stream of research has proposed that analytic and holistic thinking styles are the main underlying mechanism for cultural differences (see Chapter 1, Section 1.3.3 for an alternative view). One way to investigate this proposal can be by using a priming methodology to activating a particular thinking style within an individual. One could also activate values that are common to a specific culture by priming participants to those concepts and then testing whether it results in similar behaviours to those observed in different cultural groups. If so, this would provide evidence for the role of thinking style, rather than the visual features of the cultural environment. We will discuss experiments utilising priming methods in the next chapter.

Chapter 5: Underlying Mechanisms for Cultural Effects: Exploring the Use of Priming Methods

5.1 Priming Culture

A number of theories have been proposed to explain the underlying mechanisms of cultural differences in scene perception. As it discussed in Chapter 1, section 1.3, one account is based on the analytic/holistic attention processing styles, which are argued to be due to the differences in social practises adopted in the individualism and collectivism cultures (e.g., Miyamoto, Nisbett & Masuda, 2006; Miyamoto, 2013). The other account is based on the visual environment, the more visual environment is cluttered, the fewer tendencies to adopt local attention processing style (e.g., Davidoff, Fonteneau & Fagot, 2008). In the present experiments, social priming method was used to test whether activating individualism/collectivism related cognition and behaviours would influence visual attention in a similar way that was previously found when using two actual cultural groups. This method allowed us to rule out the environmental account if the British participants who were primed to the collectivistic self-concept had shown the Saudi Arabian's pattern of visual attention and eye movements.

The experiments conducted so far have shown some evidence of cultural variation in scene perception. As stated earlier, the results were at least in line with a number of other studies in the field (e.g., Chua, Boland, & Nisbett., 2005; Goh, Tan & Park, 2009). The underlying mechanisms for cultural differences in scene perception worth further investigation, McKene et al. (2010) tested the tendency to global attention processing, and some possible factors that may cause this tendency such as individualism/collectivism and the environmental account, the later factor was tested by using an additional Chinese group, those who born and raised in Australia, as those participants should not be affected in any way by the complexity of the East Asian physical environment. Based on the findings, the physical environment account was not strongly supported as the Asian-Australian participants had shown a global preference on the Navon task in a same way that found with East Asians participants. The findings of this study also showed that the global tendencies for East Asians could not be attributed to individualism/collectivism dimension, as there were no correlations between independent/interdependent self-construal and the global preference. However, one would note that based on the fact that subjects in that experiment were born and raised in a Western culture, it is more likely for those subject to show no interdependent self-tendency. The authors concluded that cultural differences in visual attention are likely to result from more than one aspect of culture, such as early language exposure, and situational variables.

The lack of research in this area could be explained by the difficulty in testing some of the aforementioned suggested mechanisms through experimental investigation. It may also be due to the fact that opinions on the very existence of cultural variation in scene perception remain equivocal; studies thus continue to focus on reaching a consensus on this point before trying to explore the functional basis of the differences. In the previous chapters, we have found some evidence in favor of the existence of these cultural differences; it is, therefore, logical for us to progress to investigate some possible explanations.

It is impossible to change an individual’s culture to test the effects of such a change on their ways of processing pictures and perceiving the world in general. However, the priming method provides a good alternative method to cue the factors that are believed to be at work in such situations, and to investigate the influence of simple manipulation on the behaviour studied. The priming method essentially consists of asking participants to engage in a brief, simple task before the task that is to be examined, in order to examine how exposure to a priming task affects performance in the subsequent task (Oyserman & Lee, 2008). In the priming task, the emphasis is on keeping participants uninformed of the aim of that task so that the concept cued by this task at the unconscious level spills over into the subsequent task (Bargh, 1992; & Oyserman & Lee, 2008).

Bargh and Chartrand (2000) retrospectively tracked the use of the term 'priming' in the scientific literature, and they found that its first appearance was in a paper published by Lashley in 1951, in which he used the term to refer to 'a preparedness of mental representations' (p. 3). His work focused on the necessity of a mediating state between the act of intention and the production of the intended behaviour. It was not until 1960 that the term was used to mean "the effect of recent use of a concept in one task on its probability of usage in a subsequent, unrelated task" (Bargh & Chartrand, 2000, p. 4). Since then, it has been used as an experimental technique to manipulate perceptual phenomena. The idea behind the priming method is that exposure to a prime should activate certain behaviours and ways of thinking. Therefore, one of the central principles necessary for its use is the concept of availability. It is necessary that the concepts being primed already exist and are available in the subject's own knowledge system; otherwise the prime will fail to access and temporarily activate those concepts. The emphasis here for adopting this method, is to allow us to test whether the differences in attention processing styles are due to the individualism/collectivism dimension's related beliefs and behaviours, while controlling in the same time some other confounding variables such as the length of stay in the UK or in any Western countries, and more importantly, controlling visual environmental account as both tested groups are exposed to the same visual environment.

This method of studying cross-cultural differences has been closely linked to the dynamic constructivist approach to culture (Hong & Mallorie, 2004). The basis of this model is that cross-cultural differences are not inevitable: they are dynamic rather than static, and are in constant interaction with social contexts. Thus, differences may appear or disappear depending on the demands of the context. The dynamic approach to culture establishes two main principles: first, that culture is not a static entity; and second, that an individual can have more than one cultural frame and can switch between frames to fit the demands of the context. To be sure that it is possible for the present experiments to prime individualistic or collectivistic ways of thinking, we should take into account that these concepts must already exist in the participant's contextual and procedural knowledge. It is generally believed that every society tends to encourage a mixture of individualistic and collectivistic values for survival purposes (Oyserman & Lee, 2010), although the balance between the two tends to vary across societies. Although participants from any culture would be able to switch their main cultural framework to fit social contexts, some argue that having two cultural frames is much clearer in bicultural individuals (Hong & Mallorie, 2004) and that the prime method will, therefore, be more effective upon such individuals.

A classical study conducted by Bargh, Chen, & Burrows (1996) on social priming, which used words to bring to mind some aspects associated with these words, has received a great amount of attention. They used a scrambled-sentence priming manipulation to prime either rudeness or politeness, or neither of them "neutral priming condition." In their first experiment, they asked participants to arrange five words in a sentence believing that they were being tested on their grammar ability, the first group was primed to rudeness; the second group was primed to politeness while the third group had read neutral words “neutral condition.” They found that the participants in the rude priming condition were faster to interrupt a conversation between the experimenter and an assistant in the break session compared to the other groups. They used the same method to prime elderliness by activating the subjects’ stereotype of elderly people using words such as lonely, ancient, and grey. The results also showed that participants in the elderly priming condition had a slower walking speed after exiting the laboratory compared to those who were in the neutral priming condition. Another study was aiming to investigate the effect of priming individualism/collectivism related self-aspects on communication using circling pronounce task. Hsberstroh et al., (2002) study built on a previous work that found people tend to interpret a question about happiness and a question regarding satisfaction as they refer to the same meaning if they were presented in two questionnaires, while they tend to interpret these questions as they refer to different meanings when they were presented at the end of one questionnaire, suggesting that they were sensitive to the potentially redundant nature of both questions. Hsberstroh et al., (2002) proposed that priming for interdependent self will make participants more sensitive to the redundancy of the happiness and satisfaction questions than would subjects primed for independence. After participants were assigned to interdependent/independent priming, they were given the two questions at the end of one questionnaire, and then they filled two other questionnaires with the question of happiness at the end of the first questionnaire, and the question of satisfaction at the beginning of the second questionnaire. They found that in the interdependent group “collectivism,” the correlation between the answers of the two questions in the one questionnaire condition dropped significantly than that of the two questionnaires condition, however, this was not the case with the participants who primed with the independent self "individualistic" suggesting that the former group were more sensitive to the context, as they were more likely to avoid redundant answers.

Social priming has also been reported to successfully probe cultural differences in cognition. For example, Kühnen & Oyserman (2002) found that using pronoun-circling tasks to prime individualistic or collectivistic concepts influenced both the speed of recognizing letters in Navon task, and the accuracy of remembering the places of multiple objects in the expected direction. In their first experiment they predicted that priming independent self would facilitate identification of small letters in Navon task, while priming interdependent will do the opposite. It was found that participants with independent self-prime were faster at finding small letter compared to their search time for the large ones. In their second experiment, they showed participants who were assigned to either an independent/interdependent prime a picture containing 28 items such as a toaster, and a desk for a certain amount of time, and then they gave them an empty grid and asked them to recall and write the names of items that previously seen. Findings have shown that the interdependent prime group were better at remembering the items and their locations compared to those who were primed to the independent self. Miyamoto, Nisbett, & Masuda (2006) asked participants to imagine themselves in scenes taken from big cities in America and Japan. This task was used to prime American and Japanese participants to examine whether it would affect their ability to detect changes in the backgrounds. The results showed that both American and Japanese participants who were primed to Japanese scenes were likely to detect a larger number of background changes. Using the memory task of the Kühnen & Oyserman (2002) aforementioned study, Oyserman et al., (2008) found that East Asian participants who were primed for independent self were less able to recall the objects. In addition, they found in the stroop color recognition task that the group who primed for the interdependent self were slower to read color words that printed in colour-incongruent ink, which was expected as collectivism cues an assimilating that would likely impair the performance in a task that requires ignoring some information. They also demonstrated the same pattern of effect in a listening task, as participants in each prime group heard sounds in both ears, but asked to repeat sounds from only one ear. Collectivism priming group were slower and made more errors compared to the other group. Additionally, a meta-analysis study (Oyserman & Lee, 2008) on priming individualism-collectivism concepts and assessed its effects on values, relationality, self-concept, well-being, and cognition, found that in 67 studies using different types of primes, the median result was an effect size of about 0.47, which is similar to the differences found in country-comparisons earlier studies.

Despite the apparent successes of social priming as a method, one cannot overlook the recent questions regarding the validity of priming effects which have followed the failure of Doyen et al. (2012) to replicate one of the most well-known priming studies in social psychology (Bargh, Chen, & Burrows, 1996). However, there is a large body of work supporting the effect of this method; we should, therefore, examine several possible explanations for the failure to replicate the Bargh's findings before jumping to assumptions about the validity of the priming method itself. One possible explanation is that the procedure of priming experiments is highly sensitive to any changes that might have accrued in the experiment situations. Other uncontrolled confounding variables may interact with the prime in unexpected ways, which could lead to different findings. Kahneman (2012) recently suggested a protocol in a proposal published in the 26 September issue of *Nature* to overcome the problem of the irreproducibility of the priming effects. He suggests a fixed procedure, which would allow researchers to control the situational factors that could affect the results. A second possible explanation for the irreproducibility of the studies such as that by Doyen et al. could relate to the participants themselves: if participants are aware of the aim of the prime, they may resist its effects. It is not clear exactly how this knowledge could interact with the priming effect, but to avoid such complications, Bargh and Chartand (2000) suggested that any data collected from a participant who was made aware of the purpose of the prime should be excluded. However, assessing participant's awareness of the priming effects by only their reports is also being questioned. As Stafford (2014) claimed, the failure to report the effect might be due to a number of reasons and not just because of the unawareness of the effect itself, such as responding in a way that fits their beliefs of what should affect their behaviour.

In conclusion, the key contribution of the present experiments is that using the prime method to temporary activate individualism-collectivism related aspects "self-image and thinking styles" and examining this effect on eye movement behaviours, which seems to be an almost untouched area. Further, if the prime works, our experiments will have empirically found one of the main mechanisms of underlying cultural differences in scene perception, while ruling out other important factors such as the possible effect of physical environment on attention processes, and time spent in another culture by using the same cultural group "British participants."

5.2 Experiment 5

To further examine the mechanisms underlying cultural differences in scene perception, the present experiment was conducted to find out whether we could obtain results similar to those of Experiments 1 and 2 by activating the individualist or collectivist thinking strategies using the priming method. If similar findings were obtained one could claim that cultural differences in scene perception are due to the differences in individualism-collectivism dimension. The prime chosen was a pronoun-circling task: this focuses on a text describing a day in a city, using either first-person singular (I, me) or first-person plural (we, us) pronouns to prime individualistic or collectivistic thinking respectively (Haberstroh, et al., 2002; Kühnen & Oyserman, 2002; Oyserman, et al., 2008). The text has been provided in Appendix E.

Participants were split into two groups: those in the Individualistic group were asked to circle singular personal pronouns, and those in the Collectivist group were asked to circle plural pronouns. We chose the singular/plural pronoun-circling prime task over other individualism-collectivism primes for several reasons. First, it primes conceptual knowledge, which means it should activate relative values and ways of seeing one's self and the world. Second, it has been used with a variety of dependent variables, including cognition variables, and has shown that it has an influence on cognition including attention processes and memory (e.g., Kühnen & Oyserman, 2002; Oyserman, et al., 2008), making it one of the most frequently used priming tasks (Oyserman & Lee, 2008, 2010). Furthermore, the task is relatively easy to use and does not require any special training or preparation.

From the literature reviewed above, and if individualism-collectivism dimension underlies the differences obtained in our previous experiment, we can hypothesise that participants who have been primed to collectivism will look at the background more frequently than participants who have been primed to individualism.

They will also be less accurate in remembering old focal objects on new backgrounds if the cultural differences in scene perception are due to the variation between individualistic and collectivistic concepts.

5.2.1 Methodology.

5.2.1.1 Participants.

Thirty British participants were recruited through posters and email. Half of them were randomly assigned to the singular pronouns task (age M = 21, SD = 1.89, 13 females, 2 males) while the other half were assigned to the plural pronouns task (age M = 22, SD = 3.35, 12 females, 3 males). All participants had normal or corrected-to-normal vision. They were paid an inconvenience allowance or awarded course credits, and all gave informed consent.

5.2.1.2 Design.

The experiment used a between-subject factor of prime groups (individualistic-collectivistic) and a within-subject factor of area of interest (focal-background). In the second task "focal recognition," the four conditions of pictures (old-old/old-new/new-old/new-new) were also taken into account. The independent variables were prime groups, the area of interest (focal-background), and the four conditions of images. The dependent variables were the number of fixations on the two areas, the duration of fixations on each area, and, in the focal recognition task, the accuracy in remembering the focal object in the four conditions.

5.2.1.3 Material and apparatus.

The researcher took 74 indoor real-world photographs. The focal objects were mainly appliances that are commonly available in most households, such as an iron, a machine blender, a kettle, or cups. In order for all the pictures to be roughly matched in their low-level features, pictures were implemented on the saliency map model. Images were excluded if their focal objects received less or more than two salient points and their backgrounds received less or more than three salient values from the first six ranking points. As a result of this process, 60 photographs were chosen for the present experiment. The display resolution was set to 640 x 416 pixels. For the object recognition task, 60 photographs were used: 15 of them were repeated from the previous task " preference rating," and 15 photographs were new but included the same characters. Fifteen new photographs were created by placing old focal objects on new backgrounds and 15 by placing new focal objects on old backgrounds (Figure 5.1). All 60 photographs had single focal objects in the foreground. Eye movements were recorded with an SR Research EyeLink II system.

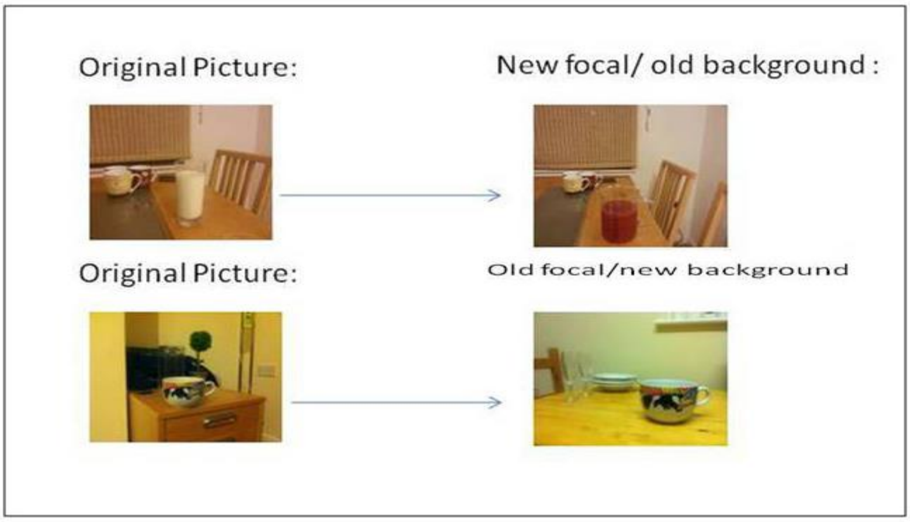


Figure 5.1. Examples of two conditions: New focal/Old background and old focal/new background.

5.2.2 Procedure.

The eye-tracking tasks (the preference rating and the recognition task) were exactly the same as the tasks used in Experiment 2, as participants were asked to perform a preference-rating task followed by a focal recognition task. The only difference was that before completing these eye-tracking tasks, participants were asked to complete the priming task, whereby they read a short passage and circle all the pronouns they came across. The whole experiment lasted for approximately 25 minutes.

5.2.3 Results.

The statistical analyses were carried out using SPSS and consisted of mixed-design ANOVAs, with prime groups (individualistic-collectivistic) as the between-subject factor and the area of interest (focal-background) as the within-subject factor. The picture condition (old focal/old background, old focal/new background, new focal/old background, and new focal/new background) was also taken into account as a within-subject factor in the focal recognition task. We will first present data on the mean number of fixations and the mean fixation durations in the preference task. We will then present the mean number of fixations, the mean fixation durations, the participants' accuracy in remembering the focal object in the four conditions, and their sensitivity to recognising old focal objects in the two conditions (partial/complete) in the recognition task.

5.2.4 Preference task.

5.2.4.1 Mean number of fixations.

Mean numbers of fixations on focal and background objects for both groups in the preference task are presented in Table 5.1. For both groups, the mean number of fixations on the focal object was greater than those in the background [$F(1, 32) = 4.12$, $p < .05$]. The data showed no main effect of the prime group [$F(1, 32) = 0.186$, $p = .53$], and there was no significant interaction between area of interest and prime group [$F(1, 32) = 0.186$, $p = .67$].

5.2.4.2 Mean duration of fixations.

The same mixed-design ANOVA was conducted for the mean duration of fixations. The results showed that both groups looked at the focal object for longer than they looked at the background (Table 3) [$F(1, 32) = 32.11$, $p < .001$]. However, neither the main effect of prime nor the interaction between area of interest and prime group was significant (respectively: $F(1, 32) = 0.46$, $p = .50$; $F(1, 32) = 1.1$, $p = .31$).

Table 5.1. *Mean number of fixations and mean fixation durations (in milliseconds) on the area of interest and background for individualistic and collectivistic groups in Task 1, numbers in the parentheses represent SD.*

	Number of Fixations		**Duration of Fixations**	
Area of Interest	**Focal**	**Back**	**Focal**	**Back**
Individualistic group	5.17	4.78	281.9	258.64
	(1.82)	(1.2)	(59.22)	(43.72)
Collectivistic group	5.1	4.51	300.24	266.62
	(0.62)	(0.41)	(72.43)	(49.96)

5.2.5 Recognition task.

5.2.5.1 Mean number of fixations.

Mean numbers of fixations on the focal and background objects for both groups in the recognition task for all trials are presented in Table 5.2. Results showed that both groups looked significantly more frequently at the focal area than the background [$F(1, 30) = 98.45$, $p < .001$]. However, there was no main effect of the prime group [$F(1, 30) = 0.92$, $p = .35$] nor was there a significant interaction between area of interest and prime groups [$F(1, 30) = 2.89$, $p = .06$].

5.2.5.2 Mean duration of fixations.

For the focal recognition phase (Table 5.2), a 2 x 2 ANOVA was conducted, with the two prime groups as the between-subject factor, and the two areas of interest as the within-subject factor. The results revealed that both groups looked at the focal object for longer than they looked at the background [$F(1, 30) = 10.96$, $p < .01$]. There was no significant main effect of the prime group [$F(1, 30) = 0.01$, $p = 0.99$], nor was there a significant interaction between AOI and the prime group [$F(1, 30) = 3.31$, $p = .08$], although the interaction was not significant, the means for the two groups were in the expected direction in the focal area, as independent prime group took longer time inspecting the focal area ($M = 322.99$, $SD = 83.89$), compared to the interdependent prime group, ($M = 295.80$, $SD = 66.97$).

Table 5.2. *Mean number of fixations and mean fixation durations (in milliseconds) on each area of interest for individualistic and collectivistic groups in Task 2, numbers in the parentheses represent SD.*

	Number of Fixations		**Duration of Fixations**	
Area of Interest	**Focal**	**Back**	**Focal**	**Back**
Individualistic group	6.86	3.17	322.99	247.04
	(1.59)	(1.3)	(83.89)	(43.72)
Collectivistic group	5.92	3.46	295.80	273.71
	(1.17)	(1.29)	(66.97)	(129.99)

5.2.5.3 Recognition accuracy.

A mixed ANOVA, with the prime group as the between-subject factor and the four image conditions as the within-subject factor, was conducted to compare participants' accuracy in recognising focal objects (Table 5.3). The results showed that there was no significant main effect of prime [$F(1, 28) = 0.04$, $p = .95$). The interaction between the four image conditions and the prime groups was also not significant [$F(1, 28) = 0.70$, $p = .41$]. However, there was a significant effect of image condition [$F(1, 28) = 12.73$, $p < .001$], as both groups performed least accurately in the old focal/new background condition. As in Experiment 2, ability to recognize old focal objects was also measured by calculating *A'* using Grier's (1971) equation. A higher *A′* value indicates greater sensitivity in recognising old focal objects. For *A′* analysis, we sorted the pictures into two categories of stimuli instead of four: the first was a 'full condition', containing the pictures with old focal/old backgrounds and new focal/new backgrounds, and the second was a 'partial condition', consisting of pictures with old focal/new backgrounds or new focal/old backgrounds. A 2 x 2 mixed ANOVA, with prime groups as the between-subject factor and the two conditions of pictures (full/partial) as the within-subject factor, revealed that these conditions had a significant effect, as both groups were more sensitive in recognising old focal objects in full condition than in a partial condition [$F(1, 28) = 40.66$, $p < .001$) ($M = 0.76$, $SD = 0.1$; $M = 0.62$, $SD = 0.05$) (Table 5.4). The results also showed no significant main effect of the prime [$F(1, 28) = 0.44$, $p = .51$], and the interaction between the prime and picture condition was not significant [$F(1, 28) = 0.37$, $p = .55$]

Table 5.3**.** *Percentage of correct answers in the four image conditions for individualistic and collectivistic groups, numbers in the parentheses represent SD.*

Percentage of Correct Answers

Conditions	**1**	**2**	**3**	**4**
Individualistic Group	12.27 (1.75)	13.53 (1.3)	10.33 (1.72)	12.1 (1.1)
Collectivistic Group	13.1 (2.11)	13.27 (1.71)	9.53 (2.23)	12.27 (1.39)

1 New/New condition 2 Old/Old condition 3 Old/New condition 4 New/Old condition

Table 5.4. *A'* values in the two conditions in individualistic and collectivistic groups, *numbers in the parentheses represent SD.*

***A'* Analysis**

	Full Condition (M/SD)		**Partial Condition (M/SD)**	
Individualistic group	0.74	(0.1)	0.62	(0.05)
Collectivistic group	0.77	(0.1)	0.62	(0.06)

5.3 Discussion

The hypothesis of the current experiment was that participants who had been primed towards collectivist thinking would look more, and for a longer period of time, at the background than the group who had been primed towards individualism, and that they would be less accurate in remembering old focal objects against new backgrounds. However, none of these hypotheses were supported as there were no significant groups differences on any of the measures, and cultural groups effect did not interact with any other factors. The results therefore suggest that the use of a pronoun-circling prime did not influence the participants' eye movement behaviours when inspecting the scenes, nor their recognition of focal objects across different conditions. Several interpretations can be provided for these unexpected results. For example, it is possible that some of the participants did deduce that the aim of the pronoun-circling task was to make them think of themselves in a specific way. This would break one of the prime conditions, which is that the manipulation should happen at an unconscious level. Participants' awareness of being primed could make them act in a different way (Bargh & Chartand, 2000), such as in a resistant or defensive manner.

Some researchers claim that the effect of the prime can be only observed when the subsequent task requires making mental efforts and filtering out distractions (Shedden, Marsman, Paul, & Nelson, 2003). One could argue that a preference task does not necessarily require a significant amount of mental effort, and the generally high performance in recognizing the focal objects under the four conditions may indicate that recognizing the focal objects was not particularly difficult either. Furthermore, it is possible that the elapsed time between the two tasks (approximately 5 minutes) was not long enough to make the task challenging. However, considering that participants were specifically asked to look at focal objects in the second task, the mean number of fixations in both groups shows that the non-significant differences between the two prime groups were in the expected direction.

Finally, bearing in mind that none of the published work on social priming that used pronoun-circling task has provided an objective way to measure its effects other than through the dependent variable, one possible explanation for our results could be that using the pronoun-circling task to prime individualist or collectivist concepts simply has a small effect on the subsequent tasks. Alternatively, it is possible that individualist or collectivist cultural tendencies are not the main factors underlying differences in scene perception and visual attention, as some recent work has already claimed (e.g., Davidoff, Fonteneau, & Fagot, 2008 & McKene, et al., 2010).

In summary, the results of the current experiment did not support our hypotheses regarding social prime effects upon scene perception. In order to reach a firmer conclusion about the effect of the priming method on eye movement behaviours, we then carried out another priming experiment after making some serious adjustments to the stimuli and the prime type for reasons stated below.

5.4 Experiment 6

The lack of a prime effect in Experiment 5 may have been due to the prime type that was used in that experiment, as it priming individualistic/collectivistic self-concepts with no assurance that it also primed the ways of thinking that are related to this dimension. Bargh & Chartrand (2000) have suggested that cognitive style priming will more likely to activate a way of thinking or mental procedure, for this, we used for the current experiment two types of priming tasks rather than one: each was supposed to work differently, as the first one “pronoun-circling task” is priming individualistic/collectivistic concepts, while the second one *Navon* is priming thinking styles that can be carried over to the subsequent task. The Navon priming task is different from the pronoun-circling prime, as it is supposed to make the subject's attention processes more global or local, which could instantly influence how participants distribute their attention when they look at pictures. We were, therefore, able to compare the effect of the manipulation of individualistic/collectivistic concepts with that of priming global/local cognitive processing. Another major change for Experiment 6 was that we used stimuli that have previously reflected cultural differences in eye movement behaviours. We, therefore, reused the images from Experiment 2, as they have already revealed differences between Saudi and British groups in the expected direction, as the Saudi group had a higher number of fixations on the background compared to the British group, and were less accurate at recognizing old focal objects on new backgrounds. We assigned 30 British participants to the pronoun-circling task; meanwhile, another 30 British participants were primed to local/global processing strategies using the Navon letters task.

5.4.1 Method.

5.4.1.1 Participants.

Sixty British undergraduate and postgraduate students from the University of Nottingham took part in this experiment for course credit or a paid inconvenience allowance. Thirty participants were primed through a pronoun-circling task: 15 of these were primed in individualism (age *M* = 21.50, *SD* = 4.42, 12 females, 3 males), and 15 were primed in collectivism (age *M* = 21, *SD* = 3.85, 11 females, 4 males). The other 30 participants were primed using a Navon task: 15 of these were primed to local thinking (age *M* = 21, *SD* = 3.42, 12 females, 3 males), and 15 of them were primed to global thinking (age *M* = 20, *SD* = 2.3, 11 Males, 4 Males). All participants had normal or corrected-to-normal vision, and none of them had participated in Experiment 5.

5.4.1.2 Design.

The experiment used between-subject factors of prime types (pronoun-circling task/Navon), and priming levels (individualistic and local-collectivistic and global) and a within-subject factor of area of interest (focal-background). In the second task "focal recognition," the four conditions of pictures (old-old/old-new/new-old/new-new) were also taken into account. The independent variables were prime type, prime level, the area of interest (focal-background), and the four conditions of images. The dependent variables were the number of fixations on the two areas, the duration of fixations on each area, and, in the focal recognition task, the accuracy in remembering the focal object in the four conditions.

5.4.1.3 Material, apparatus and procedure.

This experiment consisted of two tasks, a preference task, and a focal recognition task, which were identical to those of Experiment 5 apart from two key elements: first, we used the stimuli from Experiment 2 rather than those from Experiment 5 (see Chapter 3, section 3.3.1 for a description of the stimuli); and secondly, we added a new type of priming task to prime local/global processing styles, recruiting an extra 30 British participants. The global/local prime consists of 22 Navon letters presented using a laptop running e-prime software: it consists of larger, global letters made from smaller, local letters (see Figure 5.2 for examples). The global letters always have a different identity from the component letters. Participants were asked to speak aloud the larger letters if they were to be primed for global cognition, or to say the component letters for local priming. Therefore, there were two types of primes—the pronoun-circling task and the Navon task—each of which had two priming conditions: priming to individualism, which related to analytic thinking or collectivism, which related to holistic thinking, and priming to global or local processing strategies respectively. Participants were randomly assigned to any of these types of prime. In order to ensure uniformity of exposure time to the priming task across all prime groups, the global/local prime consisted of only 22 Navon letters: the time spent on the priming task was therefore 3–4 minutes for all participants.

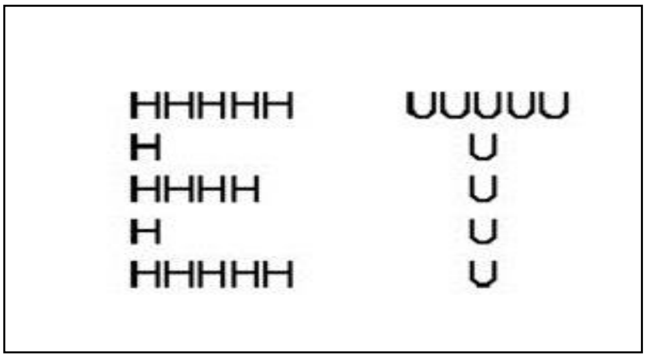


Figure 5.2. *Two examples of the Navon letter task.*

5.5 Results

The statistical analyses were carried out using SPSS and consisted mainly of mixed ANOVAs with prime types (pronoun-circling prime/Navon prime) and priming level (individualistic and local/collectivistic and global) as the between-subject factors, and the area of interest (focal-background) as the within-subject factor. The picture condition (old focal/old background, old focal/new background, new focal/old background, and new focal/new background) was also taken into account as the within-subject factor in the recognition task. We will first present data on the mean number of fixations, the mean fixation durations in the preference task, followed by the mean number of fixations, the mean fixation durations, the participants' accuracy in remembering the focal object in the four conditions, and on their sensitivity to recognising old focal in the recognition task.

5.5.1 Preference task.

5.5.1.1 Mean number of fixations.

The mean number of fixations on the focal and background objects for all groups in the preference task is presented in Table 5.5. A 2 x 2 x 2 mixed design ANOVA showed that the mean number of fixations on the focal object was greater for all groups than that on the background [$F(1, 56) = 15.58$, $p < .001$]. However, none of the interactions were significant, either between area of interest and prime type [$F(1, 56) = 0.203$, $p = .13$], or between area of interest and priming level [$F(1, 56) = 0.201$, $p = .14$]. In addition, the results showed no main effect of prime type [$F(1, 56) = 0.15$, $p = .70$] and also no main effect of priming level [$F(1, 56) = 1.51$, $p = -.22$].

5.5.1.2 Mean duration of fixations.

The same mixed-design ANOVA was conducted for the mean duration of fixations (Table 7). In Task 1, for all groups, the mean duration of fixations was greater on the focal object than the background [$F(1, 56) = 181.12$, $p < .001$]. However, none of the interactions were significant, either between area of interest and prime type [$F(1, 56) = 0.39$, $p = .54$] or between area of interest and priming level [$F(1, 56) = 3.18$, $p = .08$]. In addition, the results showed no main effect of prime type [$F(1, 56) = 0.81$, $p = .37$] or of priming level [$F(1, 56) = 1.40$, $p = .24$].

Table 5.5. *Mean number of fixations and mean fixation durations (in milliseconds) on each area of interest in individualistic/local and collectivistic/global groups in Task 1, numbers in the parentheses represent SD.*

	Number of Fixations		**Duration of Fixations**	
Area of Interest	Focal	Back	Focal	Back
Individualistic group	3.61	3.1	374.98	274.31
	(1)	(0.74)	(268.38)	(59.61)
Local group	3.43	2.96	586.18	270.34
	(0.93)	(0.99)	(161.57)	(95.18)
Collectivistic group	4.23	2.52	476.6	258.14
	(1)	(0.83)	(141.6)	(44.4)
Global group	3.69	3.16	543.33	289.53
	(0.72)	(0.89)	(124)	(101)

5.5.2 Recognition task.

5.5.2.1 Mean number of fixations.

The same mixed ANOVA for focal recognition task (Table 5.6) also showed that all groups looked significantly more at the focal area than the background, F(1,

55) = 606.40, $p < .001$. However, neither the main effect of prime type or priming level [F(1, 55) = 0.41, $p = .53$; F(1, 55) = 0.93, $p = .34$] nor the interaction between area of interest and any of the prime groups was significant F(1, 55) = 0.18, $p = .67$ for the interaction between prime type and area of interest; F(1, 55) = 0.44, $p = .51$ for the interaction between priming level and area of interest.

5.5.2.2 Mean duration of fixations.

The same mixed ANOVA for the recognition task (Table 5.6) also showed that all groups looked significantly longer at the focal area than the background F(1,55) = 40.53, $p < .001$. However, neither the main effect of the prime type or specific [F(1, 55) = 0.35, $p = .56$; F(1, 55) = 0.84, $p = .36$] nor the interaction between AOI and any of prime groups was significant F(1, 55) = 0.06, $p = .81$ for the interaction between prime types and AOI; F(1, 55) = 3.71, $p = .06$ for the interaction between prime specific and AOI.

Table 5.6. *Mean number of fixations and mean fixation durations (in milliseconds) on each area of interest in individualistic/local and collectivistic/global groups in Task 2, numbers in the parentheses represent S.*

	Number of Fixations		**Duration of Fixations**	
Area of Interest	Focal	Back	Focal	Back
Individualistic G	4.63	2	288.39	272.55
	(0.93)	(0.52)	(58.62)	(46.71)
Local group	4.49	1.91	305.82	286.68
	(0.65)	(0.44)	(55.56)	(65.36)
Collectivistic G	4.78	1.96	292.81	260.36
	(0.54)	(0.33)	(42.1)	(41.72)
Global group	4.69	2.04	292.68	259.79
	(0.56)	(0.56)	(63.73)	(36)

5.5.2.3 Accuracy in remembering the focal object.

A repeated mixed ANOVA was conducted to compare participants' accuracy in remembering focal objects, with prime type and priming level as the between-subject factor and the four conditions as the within-subject factor (Table 5.7). The analyses revealed no significant main effect of prime types, $F(1, 56) = 1.68$, $p = .20$ or of priming level, $F(1, 56) = 2.29$, $p = .14$. The interactions between the four conditions and all four prime groups were also not significant [$F(3, 168) = 0.14$, $p = .94$; $F(3, 168) = 0.28$, $p = .84$). On the other hand, the conditions did have an effect, $F(3, 168) = 23.1$, $p < .001$, as all groups did best on the old focal/old background condition (*M* = 14, *SD* = 1), and did worst on the old focal/new background condition (*M* = 12, *SD* = 1.87). A 2 x 2 x 2 mixed ANOVA with prime types and priming level as the between-subject factors and the two conditions of pictures (full/partial) as the within-subject factor revealed that the condition had a significant effect $F(1, 56) = 81.70$, $p < .001$, as all groups were more sensitive to recognising the old focal objects in full condition than partial condition (*M* = 0.86, *SD* = 0.11; *M* = 0.71, *SD* = 0.11). The results also showed no significant main effect of prime type $F(1, 56) = 1.59$, $p = .21$, or priming level $F(1, 56) = 1.80$, $p = .19$, and the interactions between prime type or priming level and the conditions were also not significant [$F(1, 56) = 0.01$, $p = .98$; $F(1, 56) = 0.29$, $p = .59$). The results of A' are presented in Table 5.8.

Table 5.7. *Percentage of correct answers in the four conditions for individualistic/local and collectivistic/global groups, numbers in the parentheses represent SD.*

	Percentage of Correct Answers			
Conditions	**1**	**2**	**3**	**4**
Individualistic G	14.33	13.47	12.47	13.2
	(0.82)	(1.55)	(1.68)	(1.73)
Local group	13.47	13.6	11	12.87
	(1.35)	(1.84)	(1.81)	(2.92)
Collectivistic G	14.27	14.13	11.87	13.27
	(0.8)	(1.25)	(1.59)	(1.83)
Global group	14.27	13.8	12.67	12.93
	(0.8)	(1.32)	(1.99)	(1.62)

1 New/New condition 2 Old/Old condition 3 Old/New condition 4 New/Old condition

Table 5.8. *A′ values in the two conditions in individualistic/local and collectivistic/global groups, numbers in the parentheses represent SD.*

***A′* Analysis**

	Full Condition (M/SD)		**Partial Condition (M/SD)**	
Individualistic G	0.85	(0.12)	0.74	(0.12)
Local group	0.82	(0.13)	0.66	(0.1)
Collectivistic G	0.88	(0.1)	0.71	(0.10)
Global group	0.86	(0.1)	0.73	(0.10)

5.6 Discussion

The results of the current experiment showed that all groups had similar eye movement behaviours regardless of the priming task. The experiment's hypothesis was that participants primed to collectivism in the pronoun-circling task or to the global level in the Navon task would look at the background more frequently and for a longer period than those who had been primed to individualism or to a local level. The results, however, did not support that prediction. In other words, the findings of the current experiment replicated our findings in Experiment 5, and the second priming task (Navon) did not seem to have a greater effect than the pronoun-circling task.

An important note regarding the findings of the current experiment is that the focal object received more frequent and longer fixations than the background for all participants. This trend was also found in our previous eye tracking experiments, and may be explained by the fact that attention is attracted to the most informative parts of the scene, which are usually in the focal area (Poole & Ball, 2005).

In conclusion, the results of the current experiment did not support our hypotheses regarding priming effects on scene perception. In order to reach a more certain conclusion about the effect of the priming method on eye movement behaviours, we carried out a final priming experiment using a visual search task, which has previously revealed significant cultural differences between the cultural groups on eye movement data (see Chapter 4, section 4.2).

5.7 Experiment 7

Results from Experiments 5 and 6 suggest that the priming method does not influence eye movement behaviour and recognition in a certain way. Experiment 7 aimed to re-examine the priming method on a visual search task presented in Experiment 3, as this task showed significant differences between the Saudi and British cultural groups on the number of fixations, RT and ScanMatch scores. If the non-significant results of the prime method experiments obtained so far are because the prime method is only effective on a certain types of behaviour such as RTs, and not that effective on some of the eye movement measures, the current experiment will provide an excellent opportunity to reveal the effect of this controversial method. However, if it does not work, no significant differences between the prime groups will show in any measure.

Although—in principle—Navon priming task should prime local/global processing directly, we choose pronoun-circling task to prime individualistic/collectivistic self-concepts for the fact that the later prime was used in the literature more often and with successful priming effect on cognition among other variables (Oysernam & Lee, 2008). It was predicted that participants who prime to the collectivism concept will show a greater number of fixations, longer RT, and less similar ScanMatch scores compared to those who prime to the concept of individualism.

5.7.1 Methodology.

5.7.1.1 Participants.

There were a total of 30 British participants: 15 of them were allocated to the collectivistic group (age M = 27.20, SD = 3.43, 6 females) and 15 participants were allocated to the individualistic group (age M = 20.56, SD = 4.75, 7 females). Participants were recruited by posters and by the Research Participation Scheme system and all of them were students at the University of Nottingham. All of the participants had normal or corrected-to-normal vision. They were given course credit, and gave informed consent.

5.7.1.2 Stimuli, design and procedure.

The stimuli, design and procedure were identical to the description provided for Experiment 3 "searching for a fruit" except for the priming task, as participants were asked to read the instructions before starting the experiment, and then given the prime text to read and circle the pronouns.

5.7.2 Results.

The statistical analyses were carried out using SPSS and mainly consisted of repeated mixed ANOVAs, with prime groups (individualistic-collectivistic) as the between-subject factor and target conditions (focal target/background target/target absent) as the within-subject factor. We will first present the mean number of fixations and the mean duration of fixations on the 60 photographs. This will be followed by the results of RT in the three target conditions, and the comparisons between the scores of the ScanMatch. We will then perform a separate analysis on the 40 images which contained the target in either focal or background locations as a within-subject factor to analyse the mean number of fixations, and the mean durations before fixating the target for the first and the last time.

5.7.3 General eye movement measures and task performance

Each mean number of fixations, mean duration of fixations, and mean reaction time in the three target conditions (target in the focal area/background/absent) were subjected to a mixed design ANOVA, with prime groups as a between-subject factor and the three target conditions as a within subject factor. Data points that exceeded a cut-off of three standard deviations above or below the mean were removed as outliers, resulting in the loss of 2.3% of the responses. First, the results of the mean number of fixations will be presented, followed by the mean duration of fixations, and finally, the mean reaction time to find the target will be presented.

5.7.3.1. Mean number of fixations.

Table 5.9 presents the mean number of fixations and mean duration of fixations for both groups in the three target conditions. For the mean number of fixations, the results showed an effect of the conditions on the participants $F(2, 58) = 46.80$, $p < .001$, as both groups made more fixations when the target was absent and less frequently when the target was in the background. However, the least amount of fixations was made in the photographs with a focal target. The main effect of prime was not significant *F*(1, 29) = 0.258, *p* = .75. In addition, the interaction between the three target conditions and priming was not significant *F*(2, 58) = 0.289, *p* = .75.

Table 5.9. *Mean of number of fixations and fixation durations (in milliseconds) in the three conditions for individualistic and collectivistic groups, numbers in the parentheses represent SD.*

	Number of Fixations			Duration of Fixations		
	Conditions of the Target					
	Focal	Back	Absent	Focal	Back	Absent
Individualistic group	3.40 (0.91)	3.83 (.1.04)	6.25 (2.49)	264.16 (46.54)	255.80 (48.87)	233.17 (21.22)
Collectivistic group	2.93 (0.93)	3.52 (0.70)	5.49 (2.30)	255.17 (47)	248.47 (40.61)	242.31 (31.88)

5.7.3.2 Mean duration of fixations.

Both prime groups (Table. 5.9) had the longest duration of fixations on the targets located in the focal area (*M* = 258.68, *SD* = 38.36) and then on the target located in the background (*M* = 252.14, *SD* = 44.31). The shortest mean duration of fixations were on the absent target conditions (*M* = 237.74, *SD* = 27), [*F*(2, 58) = 7.44, *p = .002*[. However, pairwise comparisons revealed that the only significant difference between the durations on these conditions were only between the mean duration on the focal target condition compared to the absent target condition, *p* < .001. Neither the main effect of prime, *F*(1, 28) = 0.06, *p* = .80 nor the interaction between primes and the target conditions *F*(2, 58) = 1.88, *p* = .18 were significant.

5.7.3.3 Mean reaction time.

For the mean reaction time to find the targets for correct trials, the results showed that there was an effect on the target condition [$F(2, 58) = 37.27$, $p < .001$), as both groups had the longest reaction time when the target was absent ($M = 1300.46$, $SD = 611.10$) than when the target was in the background ($M = 846.47$, $SD = 325.17$) and the shortest RT was in the photographs with a focal target ($M = 719.92$, $SD = 283.94$). However, neither the main effect of prime [$F(1, 28) = 1.59$, $p = .22$) nor the interaction between the prime and the target conditions [$F(2, 58) = 0.12$, $p = .89$] was significant. Finally, it should be noted that the accuracy was measured as per the number of photographs, which were correctly identified as "target present" or "target absent", and both groups performed with equally high accuracy as individualist priming group finding on average 91.67% SD = 11.60, and Collectivistic priming group finding in average 90.96 % SD = 8.96.

5.7.3.4 Scanpath result.

Participants in the current experiment were divided into three main comparison groups: C–C comparison, which compares the scores of each participant primed to collectivism with each participant of his/her prime group; I–I comparison, which compares the score of each participant primed to individualism with each participant of his/her prime group; and C–I comparison, which compares the score of each participant from one prime group with each participant of the other prime group—as in our case, each participant primed to collectivism with each participant primed to individualism. A one-way ANOVA was conducted to compare the ScanMatch scores for the C–C, I–I and C–I comparison groups for each target condition. Table 5.10 represents the mean scores for these comparison groups. ANOVA showed no main effect of comparisons statistically in two target conditions

[*F*(2, 431) = 1.58, *p* = .21] and [*F*(2, 433) = 0.55, *p* = .58) for the focal and background target conditions respectively. However, in the absent target condition, there was a significant main effect of comparisons [*F*(2, 58) = 37.27, *p < .001*], the contrast revealed that the I–I comparison group had a statistically higher ScanMatch score than the C–C comparison group (t (431) = 2.75, *p* < .01).

Table 5.10. *Means of ScanMatch scores in the three types of differences for C–C, I–I and C–I comparisons, numbers in the parentheses represent SD.*

Types of Comparisons	Conditions		
	Focal	Background	Absent
C-C	0.46 (0.06)	0.44 (0.08)	0.36 (0.08)
I-I	0.45 (0.07)	0.45 (0.07)	0.39 (0.07)
C-I	0.46 (0.07)	0.45 (0.08)	0.38 (0.08)

5.7.4 Eye movements on the focal/background targets.

5.7.4.1 Mean number of fixations before fixating the target for the first time and last time.

Mean number of fixations and mean fixation durations before the first fixation and before the last fixation on the focal and the background targets were subject to a mixed design ANOVA with prime groups as a between-subject factor and the location of the target (focal/background) as a within-subject factor. The results are presented in Table (5.11). Both prime groups had a smaller number of fixations before looking at the focal target for the first time compared to the targets that located in the background [*F*(1, 28) = 107.05, *p* < .001]. However, neither the main effect of prime

[F(1, 28) = 1.40, p = .26] nor the interaction between prime and the location of the target [F(1, 28) = 0.485, p = .49] were significant.

Both prime groups had a small number of fixations before viewing the focal target for the last time compared to those fixations before the targets located in the background, F(1, 28) = 94.99, $p < .001$. However, neither the main effect of prime F(1, 28) = 0.70, p =.33, nor the interaction between the prime and the location of the target F(1, 28) = 1, p = .37 were significant.

Table 5.11. *Means of number of fixations and fixation durations (in milliseconds) before first and last fixation on the foreground and background targets for Individualistic and Collectivistic groups, numbers in the parentheses represent SD.*

	Number of fixations (first/last)				Duration of fixations (first/last)			
	Focal	Back	Focal	Back	Focal	Back	Focal	Back
Individualistic group	1.59 (0.32)	1.99 (0.33)	2.40 (0.64)	2.64 (0.78)	207.53 (34.57)	202.84 (30.30)	215.13 (38.10)	200.74 (28.98)
Collectivistic group	1.58 (0.59)	2.64 (0.61)	1.98 (0.53)	2.60 (0.60)	214.08 (32.32)	212.38 (44.11)	212.86 (29.20)	207.53 (44.36)

5.7.4.2 Mean duration of fixations before fixating on the target for the first time and for the last time.

Both groups (Table 5.11) did not show any significant differences in the duration of fixations before looking for the first time at the focal and at the background targets F(1, 28) = 1.19, p = .31. In addition, none of the other effects were significant F(1, 28) = 0.780, p = .39, for the prime effects and F(1, 28) = 0.16, p = .85

for the interaction between the prime and the location of the target. For the duration of fixations before looking for the last time at the target, both groups showed longer durations with the focal target compared to the background target, $F(1, 28) = 3.56$, $p < .05$. However, none of the other effects were significant $F(1, 29) = 1.80$, $p = .19$, for prime effects and $F(1, 29) = .39$, $p = .54$ for the interaction between the prime and the location of the target.

5.8 Discussion

Experiment 7 aimed to examine whether the priming method using independent/interdependent self-images can influence eye movement behaviours in a way that reflected cultural differences, and whether the scanpath of each prime group measured by the ScanMatch method shows a higher degree of similarity when compared to the inter-group comparison.

Again, both groups showed a tendency to find focal differences more easily than those positioned in the background, as both had shorter RTs. There was also a smaller number of fixations in detecting the focal target, which is in agreement with Experiment 3 and with the central advantage theme (Tatler, 2007; Zelinsky, et al., 1997; Rensink, 1997). However, unlike the main findings of Experiment 3, we were unable to find any significant differences between the prime groups in the eye movement data except for one result. Interestingly, looking at the ScanMatch scores, we found that in a target absent condition, participants who were primed to individualism showed more similar scores when compared to those who were primed to collectivism, which is partly consistent with the results of this measure in Experiment 3, as the British-British comparison group had the higher ScanMatch score. However, the significant difference in the current experiment was only with the target absent condition, and was just between the I–I and C–C comparisons groups with no significant difference between I–I and the inter- group (I–C). Thus, considering the main non-significant differences between the groups, interpreting this finding as participants primed with individualism had more similar strategies in trying to find targets should be reached with caution. If we were finding more encouraging results to complete in this direction, it would be interesting to examine whether the Navon prime would produce similar results to the prime used in the current experiment.

5.9 General Discussion and Links Forward

In order to explore the main mechanism underlying cultural differences in visual perception, research has tried to show how temporary activation of social self-construal (independent/interdependent) can lead to differences in the perceptual process using social priming methods. This was the aim of the experiments presented in the current chapter, although the main findings did not support our predictions.

In addition to our earlier interpretations of the findings of Experiments 5, 6 and 7, there are two points worth noting. First, most of the work in social psychology using the priming method has only tested its influence on speed as measured by reaction time, or on accuracy (Wentura & Degner, 2010). The second point is that it could be argued that the social priming method has not been supported by studies of eye movement behaviours; thus, it could have weaker effect when applied to these measures. After examining different priming methods in the literature, we recommend using alternative methods to investigate its effect on eye movements in future experiments—for example, by presenting the prime at the beginning of each trial (as shown by Degner & Wentura, 2011).

In conclusion, the social priming method did not bring about any significant differences between the groups, neither in the preference and recognition experiments nor in the visual search experiment. As mentioned in the introduction to the current chapter, the priming method has been criticized for its unreliable results, and some have pointed out some serious drawbacks of Bargh's definition of priming and how it works. Stafford (2014), for instance, argued that unconscious processes that have showed to be activated by priming are only contributing towards producing behaviours and not the only ones responsible for them. He also questioned the mean that was used to measure the "unawareness" of its effect, as it mentioned earlier in this chapter (section 5.1). For this, and the reasons stated above, we prefer not go further in testing cultural differences in scene perception using prime method, as investigating the effectiveness of social priming is outside the scope of our work. However, research concerning the effects of social priming should try to answer a number of questions, such as how ambiguous the prime must be in order to work. Does it work under certain circumstances or with every type of experimental environment? How long should participants be exposed to the prime task to work and how long does its effect last?

In the current thesis, we prefer to inspect the cultural differences we have been able to uncover so far by directly testing the relationships between these differences and some of their possible explanations, such as independent/interdependent self-image scales and holistic/analytic process styles. We also aim to explore other areas in visual attention that could reveal cultural differences, which are the main aims of the next chapter.

Chapter 6: A Battery of Comprehensive Visual Cognitive Tasks

6.1 Experiment 8

The experiment reported in this chapter involved the presentation of a test battery designed to examine a wider range of visual cognitive behaviours and explore their direct links to the cultural mechanisms proposed in the literature (see Chapter 1, section 1.3). This experiment was conducted with the same cultural groups that were used in the previous experiments, with the exception that the Saudi Arabians were tested in Saudi Arabia. Importantly, these participants had never been in the UK or in any other Western country, thus eliminating any possible effects associated with cultural and environmental changes. The battery consisted of the EFT, the Navon task, independent/interdependent self-construal (as a means to test the underlying mechanisms of cultural differences in this field), a visual search task, a CVS task, and a memory task. Before providing a description of the visual cognitive tasks, we will briefly explain the rationale behind using EFT, Navon, and independent/interdependent self-construal to investigate analytic/holistic cognitive styles, and the two self-images that have previously been proposed to be in play in visual attention across cultures (e.g. Nisbett, et al., 2001; Varnum, et al., 2010).

6.2 Mechanisms Underlying Cultural Effects in Visual Perception

Social institutions and practices in any given culture play a major role in emphasising a certain number of values over others, which are reflected in how individuals within that culture see and describe themselves; they also play a major role in thinking and processing information in a way that meets their specific needs. That is, individuals who value harmony and blend in with others tend to describe themselves as interdependent and use a more holistic/global way of thinking, while those from cultures that focus on uniqueness and encourage individuals to focus on their abilities and to stand out describe themselves as independent and show a more analytical/local way of thinking (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001). What is relevant to our work here is that cultural differences in scene perception have been repeatedly explained by these two factors, which are, in turn, believed to be strongly correlated. Varnum et al. (2009) argued that the differences in these thinking styles between cultures are best explained by variations in the social orientation of the self, interdependent self-orientations as Western societies tend to be more independent and more analytic whereas Eastern societies tend to be more interdependent and more holistic. Surprisingly, there is no study to date we are aware of that investigates the correlation between these two concepts directly. There are also no available studies we are aware of that examined the direct relationships between these factors, or at least one of them, and the patterns of visual attention using different cultural groups. However, even these efforts have not made an explicit differentiation between the available tests that claimed to assess these concepts, which could result in mixed findings. Below is a description of these concepts with a discussion on this particular issue.

6.2.1 Analytic (local)/Holistic (global) cognitive styles.

The analytic/holistic thinking style is one dimension that appears since research on cognitive styles has begun under different names that usually reflect the task used to uncover this dimension, such as field-dependent/field-independent (Witkin & Asch, 1948) and broad-narrow categorization (Perrigrew, 1958), among others (see Riding & Cheema, 1991, for a review). The shared aspect of most of these tests is that at one end of this continuum, there is a tendency to process information in detail, or its parts (analytic), while at the other end, there is a tendency to process information globally (holistic) to perceive the whole. However, using these terms interchangeably (Peterson & Rhodes, 2003), pose a question on whether the results obtained were a reflection of real differences on this dimension or simply due to the differences in identifying and measuring these terms.

The present battery utilised two particular tests from amongst those that have claimed to investigate holistic/global and analytic/local processing styles: the first one was the EFT, which we used in Experiments 2 and 3 to examine analytic/holistic cognitive styles between Saudi and British groups, and it showed the predicted pattern between them. The second test was that of Hierarchal Navon Shapes, which we also used in Experiment 6 to prime local/global attention styles. The EFT is one of the most widely used tests of field independence (analytic style)/dependence (holistic style), and has been frequently used in a wide range of contexts, such as psychometric testing (Chapman & Calhour, 2006), and to measure the central coherence in the field of autism research (Frith, 2003). More appropriately in the present context, it has previously been used to differentiate collectivist cultures from individualistic cultures (Kühnen, Hannover &Schubert, 2001). Using this test in the current work provided us with a means to directly measure the correlations between these cognitive styles and independent/interdependent self-images on one hand, and its links with the scene perception experiments on the other hand.

The second test—measuring global/local attention processing style—was developed by Navon (1977). It requires global/local identification of hierarchical shapes with larger letters or geometric shapes—representing the global level—made up of small ones, representing the local level. The letters at the local and global levels could either be congruent (the letter at the global level is identical to those of the local level), or incongruent (the letters at the two levels are different), (Navon, 1977; Milne & Szczerbinski, 2009).

A number of studies have used the Hierarchal Navon Shapes test to investigate the differences between different cultures on the global/local attention processing styles. A study, for instance, conducted by McKene et al. (2010) found that East Asian participants (from Hong Kong, China, Singapore, Malaysia, Indonesia, and Korea) were faster and more accurate at the global level when compared to the performance of participants from Australia. However, no significant differences in RT to local letters were found between both groups. The results of this study supported the theory that the collectivist structure and dependent social practices of Eastern cultures encourage a global way of thinking. However, a series of experiments that compared the performance of the British sample (generally belonging to an individualistic culture) with the Himba sample (a remote culture in northern Namibia which displayed general characteristics of a collectivistic culture) on the Hierarchal Navon Shapes test revealed findings opposite to that of the former study. Himba participants showed an extreme tendency to choose local shapes over global shapes when they were asked to decide which of the two figures looked most like the target; one choice shared global congruency to the target while the other one shared local congruency to the target (Davidoff, Fonteneau, & Fagot, 2008; Carparos, et al., 2012). (See Chapter 1, section 1.3.3 for some proposed interpretations related to the visual environment notion and follow-up research in the case of the Himba group).

Interestingly, although attending to the stimuli locally/analytically or globally/holistically has been repeatedly provided as one of the best explanations of cultural differences in scene perception (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Jenkins, et al., 2010), there have been relatively few studies of this topic. Morepver, they have tended to use different tests to detect the preference to attend holistically (globally) or analytically (locally), assuming that all of the tests reflect the same underlying mechanisms construct. However, this assumption was not as safe as it would appear to be. For example, both Milne & Szczerbinski (2009) and Booth (2006) found that the EFT and Navon hierarchical tasks loaded onto two separate factors: the former study found only a positive correlation between accuracy at detecting local shapes with accuracy at dis-embedding the simple figures. Booth (2006) study found two principle components, the first one, which interpreted as a visual segmentation factor received loadings from EFT and block design tests, while the second one that interpreted as a visual integration factor received loadings from Navon hierarchical figures and possible/impossible figures. To clarify this issue and to directly test this explanation for cultural differences, one aim of the current series of experiments was to find the relationships between the Hierarchal Navon Shapes test, EFT, and independent/interdependent self-construal, which may help uncover what seems to be a inconsistent results in some of the aforementioned studies. Specifically, investigating the relationships between thinking styles measured by these two tests and their corresponding self-orientations will help to clarify the findings of Davidoff & his colleagues' series of studies, which found that subjects from collectivistic culture, with an interdependent self-tendency were more analytic than subjects from individualistic culture who should tend to show more independent self-orientation.

6.2.2 Independent/Interdependent self-construal.

As discussed in Chapter 1, the individualism-collectivism dimension is one of the explanations provided for the cultural differences in visual perception. Independent/Interdependent self-images reflect this dimension at an individual level with a “personality-like variable” (Markus & Kitayama, 1991; Oyserman & Lee, 2010). The self of every individual is thought to have three aspects: private, public, and collective (Greenwald & Pratkanis, 1984; Triandis, 1989). The tendency to express a private or collective aspect in social situations indicates independent/interdependent tendencies. As mentioned in the Chapter 5 (section 5.1), growing research suggests that even though people show a tendency to resort to one of these modes of self, the ability to switch from one self-construal to another based on a given situation is very possible (Yamaguchi, Kuhlaman & Sugimoris, 1995; Cross & Markus, 1991).

The concept of self-construal is defined as “a constellation of thoughts, feelings, and actions concerning one’s relationship to others, and the self as distinct from others” (Singelis, 1994, p. 581). Independent self-construal, most commonly found in Western societies, is conceptualised as the tendency to emphasise the inner abilities and uniqueness of each individual, and to prioritise the expression of personal thoughts and feelings and the promotion of individual goals (Singelis, 1994). This cultural trait leads individuals to adopt a thinking style different from that of individuals with interdependent self-construal, which means a tendency to be more external, emphasise on public features such as status, value, belonging, fitting in, indirect communication, and to focus on harmony (Singelis, 1994).

One of the most common scales that have been used since the establishment of independent/interdependent modes of self, is the independent/interdependent self-construal scale created by Singelis (1994). Other researchers in this specific field recommend this scale, as it has the ability to capture the cultural definition of the self (Triandis et al, 1995) and it also has acceptable reliability values as it described in this chapter, section 6.5.1 (Singelis, 1994). Based on the proposal by Varnum et al.

(2009), that differences in tendencies to use analytic or holistic cognitive styles across cultures were due to the corresponding differences in social orientation being independent or interdependent, and on the fact that Westerners tended to score higher on independent self-construal while Easterners tended to display interdependent self-construal (see Oyserman, Coon & Kemmelmeier, 2002), we were interested in investigating this factor between Saudi Arabian and British participants to see how it correlates with former tests that measure and identify cognitive styles.

6.3 Visual Cognitive Tasks

6.3.1 Visual search.

As discussed in the Chapter 4, section 4.1, in the literature of cross-cultural studies on visual attention, the tasks that are repeatedly used are preference tasks, and less often, recognition and preparation for memory tasks. Other tasks, such as visual search, are mainly overlooked. In order to provide an opportunity to test whether we could obtain similar RT results to those of Experiments 3 and 4, we conducted two visual search tasks. One required participants to searching for a target item amongst distractors (i.e., the same stimuli used in Experiment 3), and the other was a CVS task, where participants were required to discriminate a central or peripheral mismatch in a clutter of array objects. The variation in the latter task from the one used in Experiment 4 enables us to investigate how the type of stimuli can influence the efficiency of search performance. If the pattern of Saudi and British performance experiment differs from those of Experiment 4, the manipulation made to the current experiment—type of stimuli—is clearly worthy of more investigation. For example, if the longer RT for Saudi Arabian participants in Experiments 3 and 4 were due to the structure of the stimuli, as the coherence of those scenes prevent them from focusing on the individual targets (i.e., matches or mismatches), we can predict that their RT will be decreased with an array of individual objects with no whole meaning of the scene. In Kuwabara & Smith's (2012) study, they found that Japanese children had longer RT compared to the Americans when using real world scenes, however, this difference disappeared when using a cluttered array, the different findings between their two experiments conducted on the same samples was interpreted as a result of the differences in the types of stimuli, as the relational structure of the scenes appeared to increase the searching time for Japanese participants. In future work, we could also build an advanced version of this experiment using eye-tracking technology to find out how that would be reflected in participants' eye movement behaviours.

6.3.2 Visual memory.

Over the past few years, a number of studies have begun to investigate the influence of culture on memory (e.g., Masuda & Nisbett, 2001; Chua, Boland & Nisbett, 2005). Some of the research conducted in this area found that Westerners and East Asian participants differed in their free call of social interaction events, as Westerners tended to remember more about central characters relative to others; in turn, East Asians recalled more social interactions and more people compared to the first group (Wang & Conway, 2004; Wang & Ross, 2011; Chua, Boland & Nisbett, 2005). It was also found that Easterners were generally less accurate at remembering focal targets when they were placed in new backgrounds (Chua, Boland, & Nisbett, 2005). This pattern was found in Experiment 2 of the current thesis, as Saudi participants tended to be less accurate at remembering focal objects in novel backgrounds. In that experiment we tested the memory at a recognition level, therefore, the main aim of conducting a memory task here is to extend our work in the field of cultural differences in scene recognition. We treated the experiment of

Kühnen & Oyserman (2002) as the foundation of the current experiment; they focused on the investigation of the influence of priming independent/interdependent self-construal on remembering items that were located in central/peripheral areas. Their task was basically recalling 28 items in a picture after inspecting them for 90 seconds; this was after being primed to one of the two self-construal texts. They found that priming participants with interdependent self-construal made them better at remembering objects in their locations, which indicated that they were better at contextual information. The main innovation in our task was a modification of their design, as instead of using one photograph containing 28 items, we used 30 photographs to increase the statistical power. We also created two conditions: an easy condition that contained 7 common items (15 trials), and a hard condition, which contained 11 objects (15 trials). This allowed us to compare the performance of each group when more or less effort was required. Although this paradigm has not yet been used to explore differences between culture groups, we propose based on the strong relationship between what is attended to and what is remembered, and based on the findings of Kühnen & Oyserman (2002) study, that the memory of objects located in central and peripheral areas will be affected by culture in the expected direction.

In conclusion, the reason for conducting the behavioural visual tasks battery (standard visual search, comparative visual search, and items/location visual memory task) was to enable us to create a profile for each participant and test the relationships between their scores on a self-construal scale, EFT, Navon shapes and their findings on these tasks. In addition, it also enabled us to verify the findings of our earlier experiments by testing the differences between the two groups in these additional tasks. Thus, we will be able to investigate cultural effects that we so far deciphered through a number of visual tasks. Another advantage of the current work is that it allowed us to test Saudi participants in Saudi Arabia, as in our previous experiments Saudi participants were located in the UK, which has different visual environment, and different social practices that could impact visual attention in a certain way (e.g., Caparos, et al., 2012 & Kitayama, et al., 2003). Testing Saudi participants in Saudi Arabia would add up to the work that has been done by Davidoff, Fonteneau, & Fagot, 2008; Carparos, et al., 2012& Kitayama, et al., 2003) to investigate whether a certain amount of time exposed to a different culture could alter the way people perceive the world.

6.4 Methodology

6.4.1. Participants.

Seventeen Saudi Arabian participants (age *M* = 20.25, *SD* = 2.60; 7 females) and 17 British participants (age *M* = 19.94, *SD* = 1.78; 9 females) were recruited for this series of experiments. Saudi Arabian participants were tested in Riyadh, Kingdom of Saudi Arabia, during the summer vacation. None of them had visited the United Kingdom or any other Western country before. The British group was recruited through posters and the research participation scheme system, and all of them were students at the University of Nottingham. All the participants had normal or corrected-to-normal vision. They were paid inconvenience allowance and gave informed consent. The university's ethics committee approved the protocol.

6.5 Experimental Tasks

6.5.1 Independent/Interdependent self-construal.

The scale (Appendix F) was developed by Singelis (1994) and consists of 12 independent items, such as "I enjoy being unique and different from others in many respects" and 12 interdependent items, such as "I do my own thing regardless of what others think." Each item was rated on the Likert scale from 1 (strongly disagree) to 7 (strongly agree). Singelis (1994) conducted an exploratory analysis, the 24 items were loaded on two factors: independent and interdependent self- construal. The relationships between these two factors were found to be orthogonal or slightly positive (Kwan, Bond, & Singelis, 1997). Treating independent/interdependent self-construal as orthogonal constructs, they were measured by calculating the average response to items from each subscale separately. Cronbach's alpha reliability for independent self was 0.69, and for the interdependent self, it was 0.73. These alpha values are considered to be moderate and typical in cross-cultural research Oyserman, Coon & Kemmelmeier (2002).

The Arabic version for the Saudi participants was obtained by the researcher through the back translation procedure and filled out by 300 of Saudi participants online. In Arabic version, Cronbach's alpha reliabilities for independent/interdependent self-construal were 0.66 and 0.66 respectively. We predicted that the British participants would display greater independent self-construal, whereas Saudi Arabian participants would tend to show greater interdependent self-construal, this was based on previous work, discussed in Chapter 1, section 1.3.1, which found strong correlations between culture and self-construal (see Oyserman, et al., 2002; Norenzayan, Choi, & Peng, 2010)

6.5.2 Computer-based experimental tasks.

Computer-based tasks were presented using a laptop running E-Prime software. The experimenter used Adobe Photoshop CS6 and PowerPoint software to create the stimuli of all of these experiments, except for the visual search task that used the same stimuli of Experiment 3 (with size adjustment). The approximate distance was set to 60 cm from the computer screen. All stimuli were displayed centrally on a white background. Participants responded by pressing specific keys on the keyboard. For the CVS and memory tasks, to fulfil the purpose of achieving an objective decision to divide the photographs into central and peripheral areas, 4 x 4 or 7 x 7 grids were created to divide each stimulus into small squares. After that, the individual objects were placed on central and peripheral squares, and then, the grids were made invisible.

6.5.3 Experiment 6A: Embedded figure test.

Stimuli and procedure.

Participants were asked to perform the embedded figures test (EFT) on the laptop. The test was originally developed in 1950 by Witkin to measure an individual's ability to distinguish figures from their contexts. Individuals who spend less time finding figures are considered to be field-independent (analytic), while those who spend longer time finding figures are considered to be field-dependent (holistic) (Witkin & Asch, 1984). Figure 6.1 shows an example of this test. After the task was explained, participants first completed three printed-paper figures for practice; then, the task began and they were shown the 11 figures in their original order.

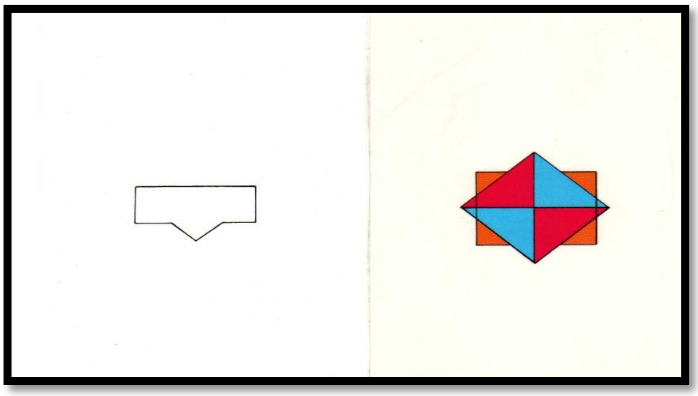


Figure 6.1. *An example of Embedded Figure Test*

6.5.4 Experiment 6B: Navon task.

Stimuli and procedure.

Sixty geometric hierarchical shapes were created using six target shapes (square, triangle, rectangle, circle, pentagon, and hexagon). In the stimulus the target shape was positioned at the top and the complex shape was positioned below surrounded by a light grey frame. Stimuli were 500 x 400 pixels in size. Both target and complex figures were placed in the center of the frame in order to avoid any effects of the left/right (dominant) hemisphere (Milne & Szczerbinski, 2009). Each stimulus was presented in the middle of the laptop screen against a white background.

In the current experiment, we were interested in testing the direction of attention to the global or local level of stimuli. For this, in all trials, the global and local levels were inconsistent, and the task was to press "1" if the target shape above was present, locally or globally, in the complex shape underneath, or to press "0" if the target was absent on either level. They were shown examples of target present and target absent trials. This task had no explicit instruction to attend to either level, allowing individual preference for one level or the other to be freely expressed.

Target figures could appear in the complex shapes at the small local level (15 photographs) or the large global level (15 photographs), and the target was absent in 30 photographs to eliminate the guess responses (see Figure 6.2). The participants were given three examples to ensure that they understood the task's instructions, and then they did five practice trails after the proper experiment began. Before the appearance of each stimulus, a central fixation cross appeared for 500 ms, after that the stimulus appeared until a response was generated. The participants were asked to response as quickly and accurately as they could.

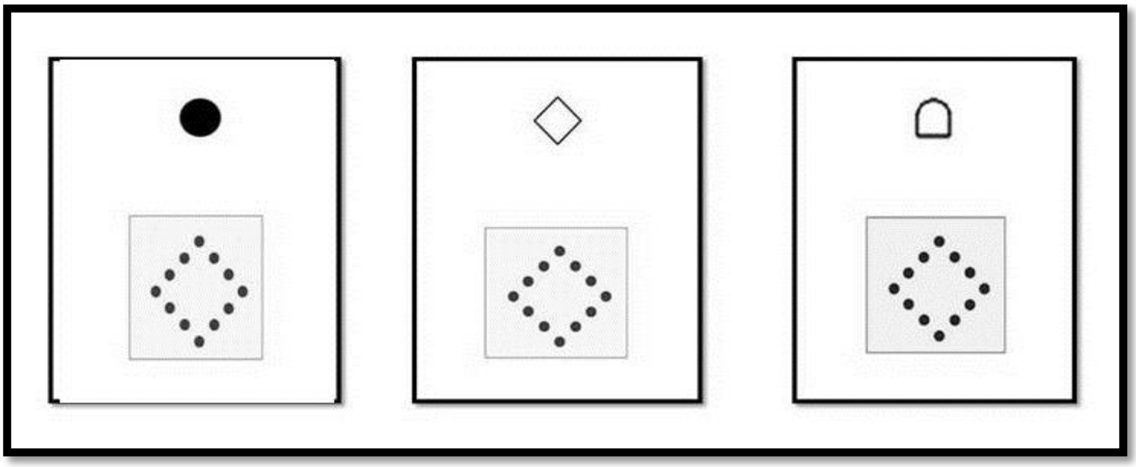


Figure 6.2. Examples of local/global/absent targets from left to right.

6.5.5 Experiment 6C: Visual search.

Stimuli and procedure.

We reused the images from Experiment 3 with 20 photographs with fruit in the focal area, 20 photographs with a fruit in the background, and the last 20 photographs with no fruit at all. Photographs were set to 525 x 400 pixels, and each one was positioned in the center of the white screen.

Participants were asked to press "1" on the keyboard whenever they detected a fruit, and press "0" if the photographs did not contain a fruit. The fruit was absent in 33.3% of the trials to eliminate the guess responses. The procedure for each trial was central fixation cross for 500 ms; stimulus; and then the fixation cross again. There were five practice trials. The viewing distance was approximately 60 cm.

6.5.6 Experiment 6D: Comparative Visual Search Task

Stimuli and procedure.

Forty stimuli consisted of paired photographic images arranged side by side on the center of a white background (Figure 6.3). The distance between the edges of each pair was 2 cm, and between the corresponding objects was 10.66 cm. Each pair contained nine arrays of common objects that were deemed to be equivalent across culture (such as fruit, vegetables, and kitchen equipment) that were presented on a white background. One of those objects was subject to change in one image, which is the single difference that should have been detected by the participants. The changes made to the objects included changing its color, rotating it, deleting it, or substituting it. Those changes were made to one object placed either in the central area (20 photographs), or in the peripheral area (20 photographs). The placement decision of the central and peripheral objects was made based on dividing photographs first into 4 x 4 invisible grids with the four squares around the center to indicate the central objects. The size of the paired images was set to 600 x 344 pixels. Participants were instructed to find the mismatch as quickly as possible and indicate it using a pen provided by the experimenter while the finger of the researcher placed on the space key from the starting of the experiment, and pressing it when the participant successfully found the mismatch. The procedure for each trial was central fixations cross for 500 ms; stimulus until the space key was pressed; then the fixation cross again. There were three practice trials. The viewing distance was approximately 60cm

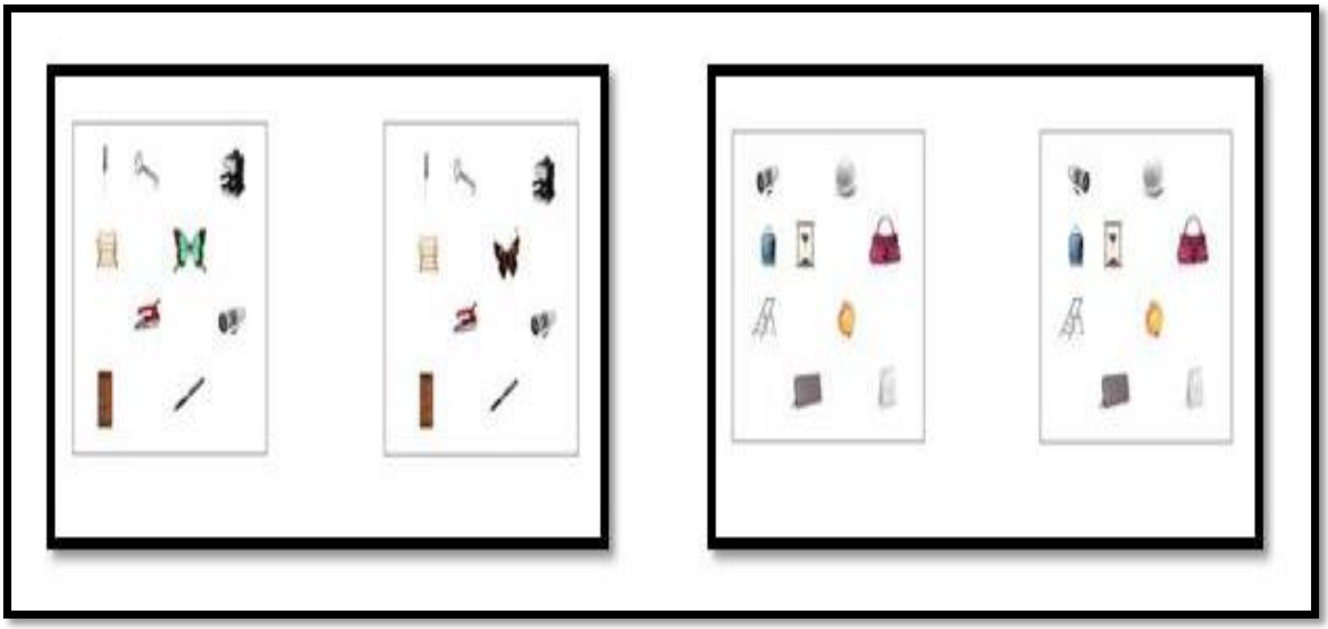


Figure 6.3. Examples of central and peripheral mismatches from left to right.

6.5.7 Experiment 6E: Visual Memory Task.

Stimuli and procedure.

Thirty stimuli (Figure 6.4) were created using Photoshop software: 15 pictures contained 11 common objects (i.e., the "hard" condition) and 15 pictures contained 7 common objects (the "easy" condition) (see Appendix G for the list of objects used). When creating the stimuli, we tried to avoid grouping common objects that are known to be associated; for instance, toothbrush/toothpaste, to prevent using learning strategies that could vary across individuals, and then facilitate the memory of objects (Torralba, et al., 2006). Stimulus arrays were 503 x 400 pixels in size.

Participants were told that each picture would be presented for 40 seconds, during which they were free to use any way they preferred to memorise the items. After the picture disappeared, a central fixation cross appeared until the space key is pressed, participants were given an empty 7 x 7 grid sheet—the size same as the original array—and they were asked to write down in the cells of the grid the names of the items they saw in the places they saw them. They were given a maximum time of 40 seconds to record the items, following which the next picture was presented. After finishing the first 15 pictures, participants were allowed to take a break for as long as they felt necessary.

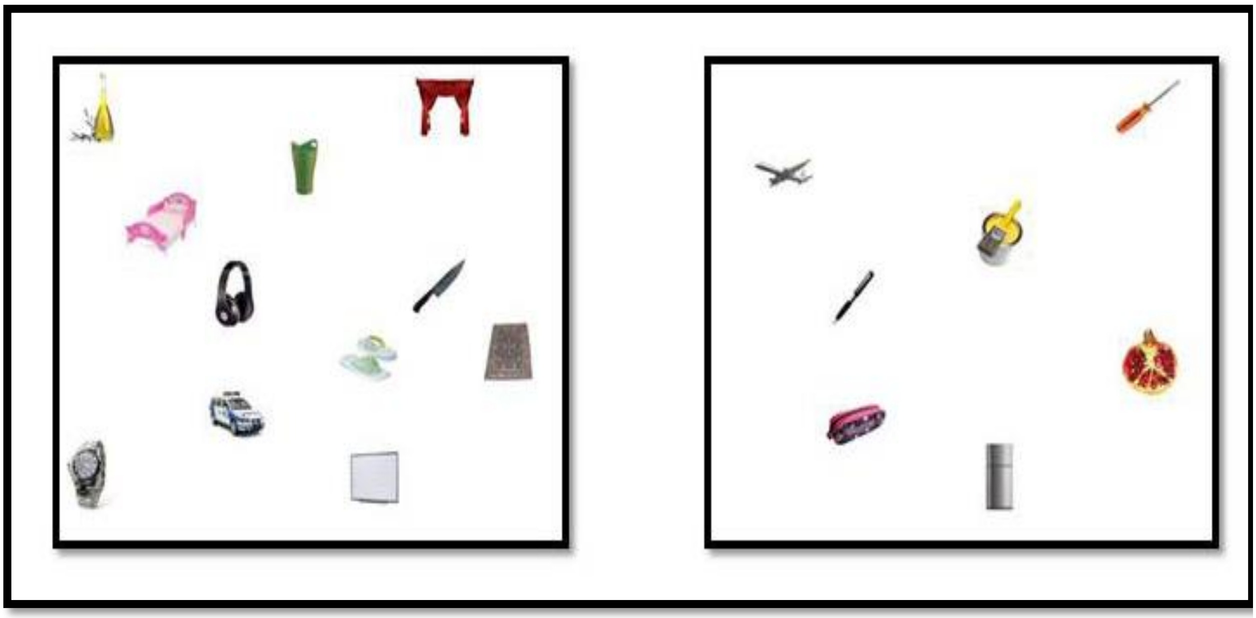


Figure 6.4. Examples of array of items in the hard and easy conditions from left to the right.

6.5.8 General procedure and design.

A general procedure for the whole set of experiments was as follows: participants were given written instructions and an information sheet. They then completed the consent form and were told they would be given a series of computer-based experiments and a short questionnaire.

Half of the participants in each cultural group were asked to fill the self-construal questionnaire before doing the computer-based experiments, while the other half were asked to fill it out at the end. All participants performed the computer-based experiments in a fixed order (sequence): visual search, EFT, CVS, Navon task, and the memory task. This order was decided after conducting pilot experiments on three volunteers. During this pilot, it was noticed that those who did the memory task—the longest experiment—in the first-half of the duration of the experiment felt exhausted sooner than the other two volunteers. The whole set of experiments lasted for approximately 70–80 minutes. The series of experiments was performed in one session with a 5- to 8-minute break offered before the memory task. However, most participants chose not to take that break; another break, as mentioned earlier, was taken after doing 20 stimuli of the visual memory task. All computer-based experiments were analysed using mixed-design ANOVAs, with culture as the between-subject factor (Saudi Arabian/British) and AOI as the within-subject factor of stimulus (focal/central or background/peripheral). The independent variables were cultural groups, the area of interest (focal/central or background/peripheral). The main dependent variable measure was the mean, and in visual search tasks, due to the outliers was the median reaction times o the two areas. In the memory task, the dependent variable was the percentage of correctly remembered items. This series of experiments also attempted to examine the relationships among those variables employing a correlation design.

6.6 Results

The statistical analyses were carried out using SPSS software and mainly consisted of repeated mixed ANOVAs, with cultural groups (Saudi Arabian/British) as the between-subject factor and the AOI as the within-subject factor. We will first present the findings of the tests used to explore the underlying mechanism of cultural differences (i.e., the self-construal, EFT, and Navon tasks). This will be followed by the results of the visual cognitive tasks (i.e., visual search, CVS, and the memory task). Finally, the relationship between these tasks will be explored using correlational methods.

6.6.1 Self-construal.

The average scores of independent/interdependent self-construal were subject to a 2 x 2 mixed-design ANOVA with self-image (independent-interdependent) as the within-subject factor and cultural group (British/Saudi Arabian) as the between-subjects factor. Results showed that both groups scored higher on interdependent self (M = 5.19, SD = .65) than being independent [(M = 4.76, SD = 0.94); F(1.32) = 6.37; p < .05]. However, there was no significant main effect of cultural groups, F(1.32) = 0.164; p = .69, nor was there a significant interaction between self-image and cultural group F(1, 32) = 0.366; p = .55. When treating these two subscales separately, the independent t-test revealed no significant differences between the groups in either measures: [t (32) = -0.59; p =.56] for independent self and t (32) = 0.063; p = . 95 for interdependent self-construal.

6.6.2 EFT.

The time spent to identify the simple form in each complex figure was converted into seconds, then summed and divided by the number of figures. The resulting value was the subject's finding for the test, which is the mean solution time per item for that participant. The Saudi Arabian group had significantly longer mean search time (M = 19.54, SD = 7.30) than the British group (M = 1, SD = 4.23), t (32) = 3.69; p < .001.

6.6.3 Navon task.

The accuracy of the Navon task result was measured as per the number of stimuli that were correctly identified as "target found in either level" or "target absent." Both groups performed with equally high accuracy: the Saudi group correctly identified 75% of the stimuli, and the British group identified 78%. As the data for each group were skewed towards correct responses, non-parametric analyses were conducted. The two cultural groups did not differ significantly (Mann Whitney test, U (34) = 141.50, p = .93.

The mean RT of the 60 photographs was subject to 2 x 3 mixed-design ANOVA, with the level of Navon targets (local/global/absent) as the within-subject factor and cultural group (British/Saudi Arabian) as the between-subject factor. Results (Table 6.1) showed that Navon target conditions (local/global/absent) have a significant effect on the mean reaction time $F(2, 64) = 15.28$; $p < .001$. A pairwise comparison revealed that the only significant differences were between target absent and the other two conditions. Also, the main effect of culture was significant $F(1, 32) = 8.52$; $p = .006$ as Saudi group had longer RT (M = 1771.84, SD = 920) compared to the British group (M = 1389.12, SD = 419.20), and there was a significant interaction between Navon target conditions and cultural groups, $F(2, 64) = 7.15$; $p < .01$. An independent t-test with alpha adjusted to 0.017 for multiple comparisons "3 levels" revealed that the Saudi group took a longer time to detect the local shapes compared to the British group, t (32) = 2.71; $p < .01$, and a longer time searching for it in the absent condition t (32) = 7.38; $p = .002$.

Table 6.1. *Mean RT for local/global/absent target in Navon task for British and Saudi Arabian groups (numbers in the parentheses represent SD)*

	Local Target	**Global Target**	**Absent Target**
British Group	1245.52	1416.10	1505.74
	(347.33)	(358.72)	(551.8)
Saudi Arabian Group	1609.60	1456.24	2244.67
	(431.28)	(453.32)	(722.11)

6.6.4 Visual search.

The accuracy of the visual search task result was measured according to the number of stimuli that were correctly classified as “target present” or “target absent.” Both groups performed with high accuracy, as Saudi group found 92%, while British group found 98%. Only correct responses were included in the RT analysis. Mann Whitney test were carried out due to the heavy skewedness of the data, and found no significant differences between the two groups, U (34) = 129.50, p = .61.

In the two visual search tasks, due to outliers (data points exceeding 3 SD above/below group means), we used median instead of mean as a method to deal with the spurious RTs, which is a robust estimator (Whelan, 2008). The median reaction time to correctly respond to stimuli was subject to 2 x 3 mixed-design ANOVA, with the AOI (focal/background/absent) as the within-subject factor and cultural group (British/Saudi) as the between-subject factor. Results (Table 6.2) showed that AOI had a significant main effect on the median RT [$F(1, 32) = 27.49$; $p < .001$), as both groups demonstrated faster RTs for focal targets. The main effect of culture, $F(1, 32) = 23.44$; $p < .001$ was significant; a planned comparison independent t-test revealed that the only significant difference between the groups was on the median RT with the fruits located in the focal area (t (32) = 2.36; $p < .03$), as the British group found the fruits significantly quicker than the Saudi group. However, the interaction between cultural groups and AOI was not significant, $F(1, 32) = 2.46$; p =.13.

Table 6.2. *Median RT for focal/background/absent targets, and central/peripheral changes in visual search tasks for British and Saudi Arabian groups, numbers in the parentheses represent SD.*

	Searching for a fruit			Comparative Visual Search (CVS)	
	Focal	**Background**	**Absent**	**Central**	**Peripheral**
British	532.76 (48.31)	604.41 (70.21)	778.76 (287.25)	30723.35 (708.36)	3939.68 (789.10)
Saudi Arabian	620.97 (146.60)	769.88 (112)	762.85 (216.97)	4411.62 (1671.13)	4469.88 (1553.14)

6.6.5 Comparative visual search.

Accuracy in this task was not measured as the trial only ended once participants correctly located the difference. The median reaction time was subject to 2 x 2 mixed-design ANOVA with AOI (central/peripheral) as the within-subject factor and cultural group (British/Saudi Arabian) as the between-subject factor. Results (Table 6.2) revealed that the area of interest (central/peripheral) had an effect on the median RT [$F(1, 32) = 17.03$; $p < .001$], as both groups displayed an advantage in detecting the central differences compared to those in the peripheral area. The main effect of culture was also significant, $F(1, 32) = 5.03$; $p < .05$ as the Saudi group had significantly longer RT ($M = 4440.75$, $SD = 1612.19$) than the British group ($M = 3506$, $SD = 748.73$). In addition, there was a significant interaction between the AOI and cultural groups, $F(1, 32) = 13.01$; $p < .001$, which was due to the fact that the Saudi group took a longer time to detect the central differences compared to the British group, $t(32) = 3.34$; $p < .005$.

6.6.6 Visual memory task.

In this experiment, two scoring systems were created. One was based on calculating the percentage of correctly recalled objects divided by all objects in the array—for the hard condition this was over 165 items, and for the easy condition this was over 105 items. The other scoring system did the same, but also took the locations of recalled objects into account, as when the recalled item was placed in a cell that was adjacent to (in any direction) the cell that originally contained the object (original location), a participant took half score instead of one. When it was placed further than that, no score was recorded for that object, as the emphasis in the second scoring system was on investigating the ability to bond the item with its location.

The percentage of correctly remembered items for all photographs was subject to a 2 x 2 mixed-design ANOVA with condition (hard/easy) as the within-subject factor and cultural group (British/Saudi) as the between-subject factor. Results revealed that condition had a significant main effect on the percentage of correctly recalled items, [$F(1, 32) = 230.53$; $p < .001$], as both groups remembered more items in easy condition (M = 82%, SD = 10%) compared to the hard condition (M = 59%, SD = 12%). However, neither the main effect of culture, $F(1, 32) = 1.40$; $p = .25$, nor the interaction between the conditions and cultural groups, $F(1, 32) = .000$; $p = .995$ was significant.

A separate analysis conducted on the percentage of correctly remembered items in their original locations revealed similar results. The effort condition had a significant main effect on the percentage of correctly recalled items $F(1, 32) = 203.56$; $p < .001$, as both groups remembered more items in their locations in the easy condition (M = 78%, SD = 10%) compared to the hard condition (M = 57%, SD = 12%). However, neither the main effect of culture $F(1, 32) = 1.79$; $p = .19$, nor the interaction between the conditions and cultural groups $F(1, 32) = 0.088$; $p = .78$ was significant.

6.6.7 Relationships between the tasks.

Table 6.3 shows the correlation matrix between all tested variables. A negative correlation was found between independent self-construal and EFT (r = -0.37; n= 34; p = 0.05), bearing in mind that a larger numbers in EFT means less tendency to show analytic style. Also, negative correlation was found between independent self-construal and finding the local targets in the Navon task (r = -0.39; n = 34; *p* =.05). Additionally, a longer time to find the local targets in the Navon task was positively correlated with EFT (r = 0.65; n = 34; *p* = .01).

Table 6.3. *Correlation matrix between the independent variables*

		1 Inter D	2 In D	3 EFT	4 Navon Local	5 Navon Global
1	**Inter D**	_____				
2	**In D**	0.264	_____			
3	**EFT**	-0.321	**-0.370***	_____		
4	**Local Navon**	-0.311	**-0.390***	**0.648****	_____	
5	**Global Navon**	0.323	0.219	-0.219	0.210	_____

*p<0.05 level

In addition, the Pearson product-moment correlation coefficient was also computed to assess the relationship between the two visual search tasks and the independent variables, and results showed a positive correlation between the time to detect central differences in the CVS task and EFT (r = 0.40; n = 34; *p* = .05) and with detecting Navon shapes at the local level (r =. 45; n = 34; *p* = .01), and a negative correlation with the high score of independent self-construal (r = -0.34; n = 34; *p* = .05). Median RT to the peripheral differences in that task was positively correlated with RT to Navon shapes at the local level (r = 0.35; n= 34; *p* = .05), and negatively correlated with independent self-construal (r = -0.36; n = 34; *p* = .05). The Pearson product-moment correlation coefficient was also computed to assess the relationship between the percentages of correctly remembered items in the visual memory task and the independent variables (EFT, local/global Navon shapes, and independent/interdependent self-construal). The results indicated a negative correlation between the percentage of items recalled and EFT (r = -0.43; n = 34; *p* = .01) in the hard condition, and (r = -0.49; n = 34; *p* = .01) in the easy condition, and a negative correlation with Navon at the local level (r = -0.35; n = 34; *p* = .05) in the hard condition, and (r = -0.41; n = 34; *p* = .05) in the easy condition. On the other scoring system (percentage of remembered items in their original locations), the results indicate a negative correlation between the percentage of items correctly recalled and EFT (r = -0.46; n = 34; *p* = .01) in the hard condition, and (r = -0.48; n = 34; *p* = .01) in the easy condition. The percentage of remembered items in their original locations in the easy condition also positively correlated with the high score of interdependent self-construal (r = 0.36; n = 34; *p* = .05). Another Pearson product-moment correlation coefficient was computed to assess the relationship between the percentages of error made with the central items and the peripheral items as well as the independent variables. The percentage of errors made in the peripheral area negatively correlated with the high score of interdependent self-construal (r = -0.50; n = 34; *p* = .01).

6.7 General Discussion

The main aim of the current chapter was to test a variety of cognitive visual tasks in relation to the proposed mechanisms that underlie cultural differences in visual attention. We therefore employed a correlational design in order to assess whether measures of self-construal were related to different aspects of search, attention, and memory.

All of the predictions for the visual cognitive tasks were made based on the theory that the British participants, as part of Western cultures, would focus their attention on the focal/central area in the stimuli or on the task's goal, while the Saudi group would tend to distribute their attention more widely or to the contexts. Furthermore, in the memory task, the Saudi participants, due to their proposed attention to the contest, or more widely, should be more accurate in recalling items in their original locations.

In the findings of the independent tasks (self-construal, EFT, and Navon), British participants tended to show more analytic style, measured by EFT, and they were also quicker in finding the local targets in the Navon task compared to the Saudis. These results are mainly consistent with the argument that individualistic cultures tended to show a more analytic cognitive style while collectivistic cultures tended to show a more holistic cognitive style (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Jenkins, et al., 2010). They are also consistent with the results obtained in some of our previous experiments. However, no significant differences were seen between the two cultural groups in independent/interdependent self-construal; moreover, both groups had a tendency to reveal a more interdependent self-image. This finding may suggest that the Saudi and British participants do not necessarily differ in individualism/collectivism dimension to visually attend differently to scenes, thus, these obtained differences in visual attention may due to some other factors such as the differences in visual environment as Davidoff & his colleagues claim.

However, before reaching a firm conclusion about the influence of individualism-collectivism dimension on visual attention, one could notice by examining items that reflect these two self-images in the scale that they might be too general to reflect self-construal in the social context. In addition, using independent/interdependent self-construal to assess individualism-collectivism dimension may contain some risk as Fiske & Taylor (2013) have discussed the lack of research in differentiating multiple forms of interdependent self and their implications for cognitive information processing, as being interdependent could mean sacrificing one own desires in favor of his/her children, but not necessarily seeking harmony with the belonging social group, which is likely to be the kind of interdependent self that is found in collectivistic cultures. In addition, possible disadvantages of using the self-report scale in general to investigate independent/interdependent self-construal preclude any firm conclusions at this time. The correlation matrix supported the relationships between these variables, as people who tended to show an independent self also tended to show the analytic/local cognitive style; they also faced difficulty in finding the local targets in the Navon task and the embedded figures.

Turning to the main findings of the visual cognitive tasks—visual search, CVS, and memory—the Saudi group tended to have a longer RT compared to the British group, which is consistent with our previous results in Experiments 3 and 4 as

Saudi groups in these experiments had in general longer RT compared to the British group. It is also in agreement with the idea that the CVS is easier to complete for individuals with local thinking style advantage (O'Riordan & Plaisted, 2001). These findings also support the relationships between thinking styles and differences in visual attention, as a longer time to detect central differences was positively associated with holistic thinking style measured by the EFT.

The lack of differences between the two cultural groups in the memory task, when taking/not taking the original locations of items into consideration, should not be taken alone, as when looking at the correlation matrix, we found that expressing more of the interdependent self was positively correlated with binding items to their contexts, which is in agreement with the findings of Kühnen & Oyserman (2002). In addition, when the researcher asked participants at the end of this task about the strategies they used to memorise the items, some different strategies were reported across the groups: the Saudi subjects were memorising items by creating a story to link them together, such as (I woke up in the morning, "brush" my hair, cutting by "the knife" my sandwich and wearing my "pair of socks," etc.) and less frequently, repeated the names of items. A small number stated that they mainly focused on memorising a certain number of items and neglected others, such as deciding to memorise "six items in each photograph and no more." On the other hand, British participants tended to report that they memorised items by creating a functional connection between chunks of objects. For example, some of them stated that they made spatial relationships to group items together, while others tried to find verbal similarities in the names of items, so when one was remembered, the other would automatically be remembered. These different strategies were practiced even though the stimuli used were array of items and did not include any social contexts.

Interestingly, these different strategies were similar to those of Ji, Nisbett & Zhang (2004) findings, as Chinese used more relational ways to organize objects while European Americans used more categorical ways. As such, one possible direction for future research in this specific field could be to test memorising strategies and categorisations using different types of stimuli.

The longer RTs that were found across tasks for Saudi subjects are worthy of specific attention. Longer reaction times are generally indicative of insufficient search processing. However, it should be noted here first that this pattern appeared in all of the RT-based experiments conducted in the battery, despite the variety of stimuli and task requirements. It is well established that reaction time is a sensitive measure that could be affected by many factors, and can be shortened by training (Ando, et al., 2002, 2004; Fontani, et al., 2006; Visser, et al., 2007). It is therefore worth noting that while none of Saudi participants had ever been involved in experimental research, the British participants, who were students at the University of Nottingham generally had a good experience in these kinds of laboratory tasks. A similar training effect could be the explanation for the longer reaction time of the Himba sample in the study by Caparos et al. (2013), as although Himba participants showed more control over their attention to meet the task's requirement (more accurate at detecting global and local shapes among the distracters), they, on the other hand, demonstrated longer reaction times compared to the British participants. Other important factors should be taken into consideration when reaching a conclusion about the results of RTs, such as the cultural value of time, learning system, and the fact that the RT results should not be taken as the only index of attention processing, but also the time required to derive a response (Thorpe, Flze, & Marlot, 1996).

In conclusion, through examination of the relationship between variables, this battery found some evidence of the cultural variation in visual cognitive tasks, such as visual search. Additionally, these differences are strongly linked with the analytic/local thinking style. Further research could be devoted to developing more behavioural measurements for independent/interdependent self-construal, and also to carry out further eye-tracking experiments to investigate whether the differences in median RT in the CVS task, using an array of objects, could be found in eye movement behaviours.

Chapter 7: General Discussion

The experiments conducted in the present work were generally aimed at investigating the differences visual-perceptual differences between Saudi and British cultures. The primary focus was on the use of eye movement measures, and we asked whether analytic/holistic processes (derived to cultural self-construal) might contribute differently to the perception of scenes. As discussed in section 1.3, many researchers have found some influence of culture on scene perception, as measured by eye movements, and have agreed that one major reason for the obtained differences was different cognitive process preferences, namely analytic versus holistic styles. However, for the fact that these studies in their investigation concentrate only on East Asian countries to represent collectivism culture, and neglected other cultures while they share some similar features with the studied ones, they also have different characteristics that could help in understanding the roots of cultural differences. The main research question in the experiments of Chapter 3 was whether it is possible to identify cultural differences in the eye movement behaviours of Saudi and British participants. Taking a step further, in the experiments of Chapter 4, we aimed to track the effects of culture on a totally different task than those used to be incorporated to answer the question of cultural influence in this particular field. Visual search task can be considered to have a more control on attention, as it requires individuals to actively scan the visual environment to find a target object among others. Thus, if culture shows some effect on this task, that could indicate the profoundness of its influence on visual attention. Finally, the underlying mechanisms of cultural differences in visual attention were investigated using variations of prime method in the three Experiments of Chapter 5, and were tested directly in Chapter 6.

The aim of this chapter is to summarize the key findings from these experiments and work towards future research that to address cultural differences in visual attention, and further elucidate the main mechanisms underlying the differences. The alternative explanation for cultural differences in this field is discussed later, followed by possible implications of the current thesis.

7.1 Summary of the Main Findings and Future Directions

7.1.1 Does cultural effect on visual attention really exist?

A growing number of studies have been devoted to the question of whether individuals from different cultures perceive scenes differently. According to the majority of published studies, culture can help to shape the ways in which people perceive scenes and remember them (e.g., Nisbett, et al., 2001; Ji, Peng, & Nisbett, 2000l; Masuda & Nisbett, 2001). The differences in analytic/holistic thinking styles between East Asians, who represent collectivism cultures, and Americans, who represent individualistic cultures, have been proposed to explain the cultural differences in visual attention (Nisbett, 2003; Nisbett, Peng, Choi, & Norenzayan, 2001) as the first cultural group attended to the context of the scene, or bending the focal object with its background, and the second group focused on focal area in visual scenes.

In Experiments 1 and 2, the main question was whether people from a Saudi culture, which is considered to be collectivist and tends to show a holistic style (irrespective of unique characteristics such as language, religion and education system), show a similar attention patterns to that of East Asians? Experiment 2 took this further to directly test the differences between British and Saudi cultural groups in EFT, a test that investigates the cognitive ability to find a simple shape embedded within a complex figure. The design of Experiments 1 and 2 broadly replicated the typical design used in the relevant literature, with some extensions such as using photographs representing icons from Saudi and British cultures as well as neutral photographs to test the effect of the physical environment represented in the photographs and familiarity with the scenes, on eye movements.

In general, the main findings of Experiment 1 showed that Saudi group spent less time inspecting focal area of scenes, and allocated a greater number of fixations to the background compared to the British group. In Experiment 2, Saudi participants again showed a greater number of fixations on the background, and they were also more affected by the manipulation of objects on one condition (when old focal placed on new background) compared to the British participants. The findings of the two experiments in general were partly consistent with prior studies in the literature that mainly claimed that Westerners tend to fixate on the focal area for a longer period of time and have a smaller number of fixations on the background. The result of focal recognition was consistent with previous research in the field (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2006; Goh, Tan & Park, 2009), which found that Westerners were more accurate than Easterners in remembering focal objects on new backgrounds. Saudi participants do indeed seem to demonstrate a perceptual style that is similar to that of other collectivist cultures (i.e., East Asians).

One component of the work presented in Chapter 3 that needs further investigation is whether the Saudi group would be better at recognizing background objects compared to the British group as an indication of their attention to the context of the scene. Future research could use an alternation of the focal recognition task that would show the advantage of attention to the background such as using four alternative forced choice paradigm to test the ability to recognize a part of the previously seen background. Another interesting direction of research using a preference task methodology could involve increasing the number of focal objects, as the addition of competing foci may result in Saudi participants making fewer fixations to the background; an indication of less attention being paid to it.

7.1.2 Cultural effects on visual search tasks.

By using preference and focal recognition tasks (Experiments 1 and 2), the influence of culture on eye movement behaviours has been partly supported, as Saudi participants had less duration of fixations in the focal area, and more number of fixations in the background in Experiment 1, and more number of fixations in the background in Experiment 2. However, other important aspects of visual cognition, such as search behaviour, had not previously been fully explored in the literature of cultural differences in visual attention. This is important to be explored, as if cultural differences can be detected in a goal driven task, this could indicate the robustness of cultural influence on visual attention.

The prime aim of Experiments 3 and 4 was to explore whether culture can influence eye movement behaviours in visual search task, a task that has a profound effect on guiding visual attention and the distribution of eye movement measures. Another aim of these experiments was to find out whether the scan paths of British and Saudi participants would provide an additional insight into cultural differences.

The findings of Experiment 3 revealed a smaller overall number of fixations, and shorter RTs, for British participants compared to the Saudi group. This suggests that they may found searching tasks to be more difficult than how British participants did perceive them, or may indicate that they were less task-orientated compared to the British group. This also may mean that individuals with a tendency towards an analytic style perform searching tasks with a greater tendency to focus on the task at hand. This was supported by ScanMatch analysis, as the intra group comparisons of scanpaths for British participants revealed more similarity than within the Saudi group. This demonstrates a greater heterogeneity of search behaviour within the Saudi group. Whether this is indicative of cultural effects, or the fact that Saudi participants were not undergraduate psychology students is a topic for further investigation. Experiment 4 used a CVS to increase the task difficulty as a way to avoid the possibility of a pop out effects that some data of Experiment 3 have suggested. The findings of Experiment 4 revealed results similar to those of Experiment 3: British participants had fewer fixations and faster RTs, compared to Saudi participants and, again, the ScanMatch analysis revealed that the intra group comparisons of scanpaths for British participants were more similar than within the Saudi group. On the basis of ScanMatch scores, one can suggest that the findings of Experiments 3 and 4 demonstrate a greater heterogeneity of search behaviours within the Saudi group. A tendency for Western individuals to find a target more quickly is previously found (Kuwabara & Smith, 2012), which may suggest that they are more task-orientated. Along with previous research that found superior performance of European Americans in tracking multiple moving objects compared to Asians (Savani & Markus, 2012), our data may suggest that analytic cognitive processing provides more capacity for controlled attention, an advantage of being more able to direct attention towards task goals. This explanation is in line with a number of experiments, which found that people with local "analytic" processing perform better in finding the Navon-like shape, the one that shares one similarity with the target shape, when compared to those with lesser local tendency. They attributed this difference by ability for individuals with local processing to focus on the task at hand and be less distracted by the surrounding (Davidoff, Fonteneau, & Fagot, 2008; Carparos, et al. 2012). However, Miyamoto, Nisbett, and Masuda (2006) revealed a conflicted situation, as they found that participants who are primed to "Japanese scenes" displayed a greater ability to detect changes that made to stimuli compared to those who were primed to "American scenes". However, they interpreted their results not by activating analytic/holistic styles, but by the idea that visual clutters broaden attention span. Different types of visual stimuli and methodological differences across these studies could also account for the aforementioned contrasting findings. Investigating cultural differences in visual search, whilst controlling experimental designs and types of stimuli, will provide valuable information on the exact role of culture in a visual search.

7.1.3 Underlying mechanisms for cultural differences in visual attention.

The individualism-collectivism dimension is mainly expressed by the way people describe themselves and their tendency to process information in a holistic/analytical styles. The independent/interdependent self-images along with the analytic/holistic cognitive processes were proposed to be the underlying mechanisms for cultural differences in visual perception (e.g., Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Varnum, et al., 2010). The tendency to describe the self based upon ones abilities and personality traits (i.e., "independent self"), or through the roles being played in the societies and traits associated with others (i.e., "interdependent self") has been argued to form the basis of the individualism–collectivism dimension, and a better predictor of behaviours (Markus & Kitayama, 1991). Research has also provided support for the view that Western cultures (which are classified as individualistic) are more analytic or field independent when compared to East Asians (who are classified as collectivistic) on various measures. Kühnen, Hannover &Schubert (2001) for example, by using EFT have found that participants from East Asian tend to show a holistic cognitive style as they took longer time detecting the embedded figures, whereas cultures that are shown to be individualistic tend to exhibit greater analytical style, as they took shorter time detecting the embedded figures. Another study that used "framed- line test" found that the Japanese were more accurate in the relative task, which means more attention being paid to the lines in their relations to the context, while Americans were more accurate in the absolute task, which indicate focused attention to the lines themselves (Kitayama, et al., 2003). Finally, using Navon task, McKene et al. (2010) found that East Asian participants were faster and more accurate at the global level when compared to the performance of participants from Australia.

Although evidence supporting a cultural influence on visual attention is accumulating, the proposed mechanisms underlying these differences have not reached a firm conclusion and have not been fully explored. Experiments 5–8 mainly attempted to uncover some of the most proposed underlying mechanisms for cultural differences in visual perception. The social priming method was used in experiments 5, 6, and 7 in an attempt to temporarily activate social self-construal in order to explore whether it affected local and global processing. The method requires participants to activate a thinking style and self-image that is common in a specific culture by priming them to those concepts. One can then test whether the expected cultural effects can be observed after cueing these concepts. The priming method has been previously used in the field of cultural differences in visual perception and showed that priming individuals with interdependent self-construal made them better at encoding contextual information when compared to those who are primed with independent self-construal (Kühnen & Oyserman, 2002).

Using independent/interdependent self-construal and local global process prime tasks, we were able to test whether these concepts play the major role when it comes to cultural effect on visual perception and eye movements. The results of all of prime experiments did not reveal any significant differences in eye movement measures between the two priming groups; this was the case even when using different types of primes and tasks, as in Experiment 6, local/global prime as well as pronounce circling task was used, and searching for a fruit task was used in Experiment 7.

After failing to uncover the possible mechanisms underlying cultural differences in this field using priming method, we conducted a battery of tasks to test independent/interdependent self-construal and analytic local/holistic global processes in both British and Saudi participants. Importantly, the Saudis lived in Saudi Arabia and had never left it, which allowed us to eliminate the possible alternation of cognitive behaviours as a result of moving to another culture as it claimed (Kitayama, et al., 2003). Another aim of conducting the battery of tasks in Experiment 8 was to inspect other visual tasks such as visual memory task and test the relationships between the performance of these visual tasks and their possible explanations studied in this thesis. The findings revealed that Saudi participants tended to show more a holistic style, as measured by the EFT, and were slower at finding the local shapes in Navon task. This supports the idea that individuals from collectivistic cultures show more holistic processing (Chua, Boland, & Nisbett., 2005; Masuda & Nisbett, 2001; Jenkins, et al., 2010; Norenzayan Choi & Peng, 2010). In addition, correlation matrix between the tested variables showed a negative correlation between independent self-construal and EFT, in other words, subjects with high scores in independent self tended to show more analytic style. It also supported relationships between thinking styles and differences in visual attention, such as a longer time to detect central differences was positively associated with holistic thinking style, and a longer RT to the local targets in Navon task.

In order to further explore the mechanisms underlying cultural differences, future research could be devoted to test whether the high score in EFT really reflect holistic style or only a weaker tendency to analytic style. Future work to further investigate cross-cultural visual attention can be directed to conducting eye-tracking experiments that compare eye movement behaviours in a number of tasks using different stimuli between Arabs and East Asians and find out where Saudis, and Arabs in general, are located in comparison to Eastern culture as for example when we tested the tendency to local/global processing using Navon task in Experiment 8, we were not able to find any global advantage for Saudi participants compared to the British group. However, for East Asian participants, a study conducted by McKene et al., (2010) found that they outperformed American participants in detecting global shapes, which may suggest some differences between Arab and East Asians in analytic/holistic styles. In addition, our findings in visual search experiments have shown a tendency for Saudi subjects to have a greater number of fixations regardless of the target's location, and targets located in the background did not seem to shorten the searching time for them, however, this was not the case for East Asian group in a study conducted by Masuda & Nisbett (2006), which found that East Asian participants were faster at detecting contextual differences between images presented in a sequent in comparison to American subjects. Although the different experimental designs between our experiments and their, could account for these different findings, it would be still interesting to find out how Arabs can be differ in comparison to the Easterners. Another direction can study whether a certain amount of time exposed to a different culture could alter the way people perceive the world by comparing the performance of Saudi group who spent 1–2 years in Western culture with those who spent 5 years or above.

7.2 Alternative View to the Analytic/Holistic Explanation

Throughout the current thesis, we have investigated the tendency for people from an "individualistic" culture to show an analytic style, and for people from a "collectivist" culture to show a holistic style, are the only tested hypotheses for cultural differences in scene perception. However, there is an alternative explanation for cultural differences in scene perception that has not been investigated in this thesis, and that is the influence of physical environment. Davidoff & his colleagues proposed that the differences in cognitive processes (holistic/analytic) is primarily a result of the physical environment: that is, the more visually cluttered the environment, the wider visual attention is spread out, and a tendency to decrease the local thinking style is observed (e.g., Davidoff, Fonteneau, & Fagot, 2008; Carparos et al., 2012). Miyamoto, Nisbett, and Masuda (2006) found that participants who are primed to "Japanese scenes" displayed a reduced change blindness compared to those who are primed to "American scenes". They attributed this result by cultural differences in Japan and the US visual environments, as the visual environment for the former one tended to be ambiguous and cluttered that make it difficult in distinguishing focal from background, while the latest one is clearer with focal objects standing out from their backgrounds. The researchers explained the better performance of participants who are primed to Japanese scenes as the highly dense Japanese environments broaden the span of an individual's visual attention. The later study measured the environmental effects using attention to the visual stimuli and linked cluttered environment with the tendency to pay attention to the context, or in other words, holistic/global processing, to complement this, the experiments conducted by Davidoff & his colleagues in a number of experiments found that people of an urban area ‘Himba’ showed a local/analytic process preference measured by Navon task in comparison to British participants (Davidoff, Fonteneau, & Fagot, 2008; Carparos et al. 2012; Carparos et al., 2013) and attributed this difference by the characteristics of visual environment those cultures inhabit.

When we try to put the visual environment explanation into consideration with the work conducted here, we noticed that Riyadh—the city where most of the Saudi participants came from—can be described as uncluttered especially in comparison with Nottingham city (see Appendix X for some photographs of the two cities), and on the basis of the proposed relationships between visual environment and cognitive processing, British group should display a tendency to global style compared to the Saudi group, which is not the case. However, testing this hypothesis needs a deeper work that exceeded the scope of the current thesis, and the note above does not allow us to conclude anything specific about this approach. Future work should take into account the possible differences between the measures claimed to test these two processes and try to find out the exact characteristics of environments that encourage each of these cognitive styles. Another possibility for future research is to find two societies that are similar in their physical environments, in which one of them belongs to collectivism culture whereas the other belongs to individualistic culture, and to compare their cognitive and attention behaviours, as any differences will be obtained cannot be explained by this account. Additionally, another direction concerning the effect of visual environment on cognition could make use of the fact that Saudi Arabia is a large country with big cities and small towns and villages. One way to test this point of view in future work could be done by choosing two locations within

Saudi culture that differ in their physical environments and compare the ways they attend to scenes and their preference in cognitive processes.

7.3 Conclusion, Limitations, and Implications

A conclusion about the findings of the most experiments conducted in this thesis is the fact that they provided some support to cultural variation in visual attention. Although both the tested cultural groups have shown a tendency to focal/central area regardless of the variations of the task at hand, Saudi participants looked more at the backgrounds or the whole scenes compared to the British groups, which could be linked to their longer RT to some of the visual tasks when measured. Another aim of the current thesis was to explore some of the proposed underlying mechanisms for cultural effect. Using EFT in a number of experiments, we found that the British participants always had shorter mean time to find the embedded figures, which means there is a tendency for them to show an analytic processing style compared to the Saudi group. This result contributes to the small body of research conducted to directly investigate the underlying mechanisms for cultural differences in scene perception.

The findings of the current experiments pose a number of further interesting questions such as exactly how holistic/analytic processes contribute to visual search behaviour? Based on the correlation matrix in Experiment 8, is there a distinction that can be clearly made between attention styles and self-images? Finally, future work is also need to establish a firm conclusion of why cultural differences more pronounced on some tasks over others?

The results of the experiments are subject to a number of limitations. First, the small sample used in each study perhaps limits their generalizability, even though the experiments in the field usually used approximately similar number of participants in each cultural group. Another limitation of the present work was related to Saudi sample: the entire sample of Saudi participants, except for those tested in Experiment 8, were graduate students who had chosen to complete their academic studies and remain within an academic environment. Their decision to continue their study abroad and learn a new language could show that they have some particular cognitive and personality traits such as high level of ambiguity tolerance and higher tendency to independent thinking style compared to the average Saudi individual. In other words, we cannot claim that they necessarily the most representative of Saudi culture. One other limitation with regard to the sample of the current thesis is the differences between the Saudi and the British samples in academic specialism, where although there was a diversity in the academic specialities among the Saudi groups, all of the British participants were specialising in Psychology due to the fact that they were mainly recruited through the research participation scheme. Differences in academic speciality could affect the preferred cognitive styles; therefore, this factor should be controlled in any future work in this area. Differences in academic speciality could affect the preferred cognitive styles; therefore, this factor should be controlled in any future work in this area. Baron-Cohen (2002) has argued that some academic domains and gender correlates differently to holistic/ analytic cognitive styles. Based on that view, Mathematics, Physics, and Engineering are requiring a more systematic brain, which includes a greater ability to pay attention to details (analytic style). Although Baron-Cohen Simon (2010) argued that females on average tend to show a more holistic style compared to males, other studies have found quite the opposite findings (e.g., Pletzer, 2014). However, in the current thesis, with the exception of Experiment 1, males and females contributed equally to the cultural groups for all experiments.

A further limitation of the current thesis is related to the real-world photographs that are used in most of the experiments as stimuli. We used indoor and outdoor images, photographs that differed in their composition based on the fact that they represented different cultural environments (Experiments 1 and 2), and in a small cases, we used photographs consisted of arrays of items (Experiment 8). Clearly this was mainly to serve the purpose of these tasks and to explore different areas of interests, with the fact that this type of photographs is very hard to control. Stimuli can be improved by sticking to a number of elements that should be used as criteria in each picture, such as the size of focal object, its location and the amount of clutter in the backgrounds. However, in the current thesis we were interested in investigating cultural differences in scene perception using more ecological valid natural scenes as real world scenes are not tightly controlled. One possible future project that can help reach a consensus on the role of culture and the ways it worked in visual attention is to establish a high-quality image base to be the source of the work in this area, with fixed size and comparable features. In general, future work will certainly need to control for these discussed variables when investigating the effect of culture on scene perception. The findings from the experiments also have several implications. The first is that they emphasize the existence of cultural differences in visual attention. Noting that much of the existing visual attention and memory research has focused on individuals from Western cultures, and not taking other societies into account, we can claim that taking this knowledge into account will enable us to generate more applicable theories of visual attention and memory. By using different types of visual tasks and different kinds of stimuli, it is expected to find out how culture is affecting visual attention, and under what circumstances it has a maximum/a minimum effect. This, in a long run, can help building up new computational eye-movement models that allocate the role of culture in visual attention. Although incorporating the effects of culture seems too ambitious at this stage, we believe that it is possible considering the fact that new models that took the role of top-down processing into account are already developed (e.g., Wolfe, 1994), which have shown that selective attention is influenced by what matches the target-defining features. Another contribution of this thesis was to highlight the need to reach a consensus on how "analytic/holistic processing" can be best measured when used in the context of cultural differences in scene perception, whether they should be measured based on the distribution of eye movements, or directly testing them using some behavioural tasks. This would help to facilitate communication amongst researchers who proposed these processes to be the main reason for cultural differences in visual perception. This has been discussed in Chapter 6, as although analytic/holistic processing and other terms such as local/global are used interchangeably (Peterson & Rhodes, 2003), these concepts are used and measured differently. In order for future studies to reach a firmer conclusion about the main mechanisms underlying the cultural differences in visual attention, they need to compare the results from a number of countries using the same measures and comparable samples; otherwise, the findings can be because of the potential differences in these measures or the composition of samples.

One practical implication can be extended to the tools and methods used in teaching inside classrooms. Perhaps it is necessary for teachers and lecturers in Saudi Arabia to place greater emphasis on the importance of creating visual aids such as PowerPoint slides that fit well with the more common attention pattern that is believed to be there to provide more efficient teaching. Finally, another practical point can be extending the benefits that knowledge brings to the advertising field. A number of differences between collectivistic and individualistic cultures in how effectively advertisement models can work are well-established, such as the frequency of visual appearance of the brand name and the purpose of the advertisement itself, to build a trust worthy relationship or to persuade possible customers (e.g., Miracle, et al., 1992). Different visual attention patterns to the focal versus the whole should also be reflected in advertising styles across cultures.

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Appendix A. The Functional MATLAB Code

```
function[] = scanmatchanalysis()


%%%%%%%% set the parameters for the ScanMatchInfo structure
%%%%%%%%%%%

   ScanMatchInfo.Xres = ?;
   ScanMatchInfo.Yres = ?;
   ScanMatchInfo.Xbin = 16.0;
   ScanMatchInfo.Ybin = 12.0;
   ScanMatchInfo.RoiModulus = ScanMatchInfo.Xbin;
   ScanMatchInfo.Threshold = 3.5;
   ScanMatchInfo.GapValue = 0;
   ScanMatchInfo.TempBin = 0;
   % Compute substitution matrix
   ScanMatchInfo.SubMatrix =
ScanMatch_CreateSubMatrix(ScanMatchInfo.Xbin,...
         ScanMatchInfo.Ybin, ScanMatchInfo.Threshold);
   ScanMatchInfo.mask =
ScanMatch_GridMask(ScanMatchInfo.Xres,ScanMatchInfo.Yres, ...
         ScanMatchInfo.Xbin, ScanMatchInfo.Ybin);




%%% read in file with all the data and extract arrays of x and y coordinates for
each picture for each participant

fid = fopen('datafile.txt');


  fixdata = textscan(fid,'%f%f%f%s%f%f%s%f');

  xcoord = fixdata{:,1}
  ycoord = fixdata{:,2}
  duration = fixdata{:,3};
  subjectnames = fixdata{:,4};
  condition = fixdata{:,5};
  category = fixdata{:,6};
  picture = fixdata{:,7};
  picnumber = fixdata{:,8};


  subjname =  unique(subjectnames);
```

```
firstpict = 1;
lastpict = 60;


   for s = 1:length(subjname)   %% for every participant


    clear x;

    x = find(strcmp(subjectnames(:),subjname(s)));


         for k = firstpict:lastpict               %% for every picture, 1:20 for condition
21, 40:38 for condition 2, 41:60 for condition 3


      clear z;

            z = find(picnumber(x) == k);

   clear j;

   for j = 1:length(z)


   xpos(s,k,j) = xcoord(z(j)+x(1)-1);
   ypos(s,k,j) = ycoord(z(j)+x(1)-1);


   end;

   end;

   end;



   %%% use the arrays of x and y coordinates calculated above for scanmatch
analysis

   for s = 1:length(subjname)   %% do this for every participant

   resultsfile = strcat(char(subjname(s)),'_results.txt');

   fid = fopen(resultsfile,'at');  %% open file for output

   fprintf(fid, '%s\t','participant');
```

```
for j = 1:length(subjname)             %% print header for each participant
      fprintf(fid, '%s\t',char(subjname(j)));
end
fprintf(fid, '\n');



disp(subjname(s));

disp (strcat(num2str(round(s/length(subjname)*100)),'% done'));

%fprintf(fid, '%s\t',char(subjname(s)));


for k = firstpict:lastpict  %% loop to do the analysis for every picture

fprintf(fid, '%f\t',k);

for i = 1:length(subjname) %% loop to do the analysis for a comparison with
every other participant



clear data1;
clear data2;


   score(i,k) = NaN;


end;

fprintf(fid, '%.4f\t',score(i,k));   %% print the mean score for all pictures to the
output file


end;

fprintf(fid, '\n');


end;

fclose(fid);
```

Appendix B. Example of the arrangement of ScanMatch data

participants	comparsion	groupNumber	focal_target	back	absent
1_2	s-s	1	0.417116667	0.424342105	0.307258824
1_3	s-s	1	0.415077778	0.402310526	0.354211765
1_4	s-s	1	0.4329	0.409947368	0.341194118
1_5	s-s	1	0.429911111	0.470915789	0.389529412
1_6	s-s	1	0.547705556	0.547089474	0.413394118
1_7	s-s	1	0.537666667	0.535931579	0.397188235
1_8	s-s	1	0.442222222	0.459489474	0.382847059
1_9	s-s	1	0.432283333	0.471636842	0.437558824
1_10	s-s	1	0.516644444	0.541726316	0.391023529
17_28	b-b	2	0.714761111	0.608078947	0.473088235
17_29	b-b	2	0.644505556	0.705657895	0.506723529
17_30	b-b	2	0.609577778	0.555173684	0.371905882
17_33	b-b	2	0.736511111	0.558573684	0.409547059
18_19	b-b	2	0.529416667	0.543736842	0.370258824
18_20	b-b	2	0.556605556	0.558663158	0.378994118
18_21	b-b	2	0.565394444	0.517884211	0.434341176
18_22	b-b	2	0.595277778	0.523542105	0.394552941
18_23	b-b	2	0.591955556	0.580773684	0.396523529
18_24	b-b	2	0.582111111	0.491652632	0.3679
18_25	b-b	2	0.628711111	0.498621053	0.353376471
18_26	b-b	2	0.567866667	0.485968421	0.430135294
18_27	b-b	2	0.572088889	0.510115789	0.340582353
1_16	s-b	3	0.457866667	0.490605263	0.394876471
1_17	s-b	3	0.382955556	0.345510526	0.267041176
1_18	s-b	3	0.356461111	0.341563158	0.258547059
1_19	s-b	3	0.426216667	0.425431579	0.3076
1_20	s-b	3	0.401377778	0.441310526	0.347694118
1_21	s-b	3	0.460711111	0.434221053	0.358729412
1_22	s-b	3	0.471294444	0.4479	0.347541176
1_23	s-b	3	0.417566667	0.520910526	0.401723529
1_24	s-b	3	0.415405556	0.406168421	0.318241176
1_25	s-b	3	0.468027778	0.492910526	0.348847059
1_26	s-b	3	0.468938889	0.484294737	0.421147059
1_27	s-b	3	0.379138889	0.391247368	0.329652941

Appendix C. Results of ScanMatch in Experiment 3

Oneway Exp.3 ScanMatch

Descriptives

Focal targets

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
1.00	106	.5479	.06902	.00670	.5347	.5612
2.00	120	.6401	.06052	.00552	.6292	.6510
3.00	239	.5740	.07950	.00514	.5639	.5842
Total	465	.5851	.08012	.00372	.5778	.5924

Descriptives

f

	Minimum	Maximum
1.00	.38	.69
2.00	.50	.78
3.00	.36	.75
Total	.36	.78

ANOVA

f

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.539	2	.269	50.983	.000
Within Groups	2.440	462	.005		
Total	2.979	464			

Robust Tests of Equality of Means

f

	Statistic[a]	df1	df2	Sig.

Brown-Forsythe	56.889	2	388.771	.000

a. Asymptotically F distributed.

Contrast Coefficients

Contrast	typeN		
	1.00ss	2.00bb	3.00sb
1	1	-1-	0
2	1	0	-1-
3	0	1	-1-

Contrast Tests

		Contrast	Value of Contrast	Std. Error	t
f	Assume equal variances	1	-.0921-	.00969	-9.512-
		2	-.0261-	.00848	-3.074-
		3	.0661	.00813	8.126
	Does not assume equal variances	1	-.0921-	.00869	-10.607-
		2	-.0261-	.00845	-3.086-
		3	.0661	.00755	8.754

Contrast Tests

		Contrast	df	Sig. (2-tailed)
f	Assume equal variances	1	462	.000
		2	462	.002
		3	462	.000
	Does not assume equal variances	1	210.410	.000
		2	229.805	.002
		3	301.407	.000

Oneway

Descriptives						
Back Target						
					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
1.00	106	.5341	.07961	.00773	.5187	.5494
2.00	120	.5997	.06764	.00617	.5875	.6119
3.00	239	.5502	.08493	.00549	.5394	.5611
Total	465	.5593	.08317	.00386	.5517	.5669

Descriptives		
b		
	Minimum	Maximum
1.00	.38	.73
2.00	.46	.74
3.00	.34	.75
Total	.34	.75

ANOVA					
b					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.283	2	.142	22.350	.000
Within Groups	2.926	462	.006		
Total	3.209	464			

Robust Tests of Equality of Means				
b				
	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	24.010	2	369.412	.000

a. Asymptotically F distributed.

Contrast Coefficients

Contrast	typeN 1.00ss	2.00bb	3.00sb
1	1	-1-	0
2	1	0	-1-
3	0	1	-1-

Contrast Tests

		Contrast	Value of Contrast	Std. Error	t
b	Assume equal variances	1	-.0657-	.01061	-6.189-
		2	-.0162-	.00929	-1.742-
		3	.0495	.00890	5.556
	Does not assume equal variances	1	-.0657-	.00989	-6.635-
		2	-.0162-	.00948	-1.705-
		3	.0495	.00826	5.987

Contrast Tests

		Contrast	df	Sig. (2-tailed)
b	Assume equal variances	1	462	.000
		2	462	.082
		3	462	.000
	Does not assume equal variances	1	207.245	.000
		2	213.725	.090
		3	290.844	.000

Oneway

Descriptives

Absent

					95% Confidence Interval for Mean	
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
1.00	106	.3772	.05209	.00506	.3671	.3872
2.00	120	.4231	.06278	.00573	.4117	.4344
3.00	239	.3786	.06970	.00451	.3698	.3875
Total	465	.3898	.06711	.00311	.3837	.3959

Descriptives

abs

	Minimum	Maximum
1.00	.20	.50
2.00	.27	.55
3.00	.18	.54
Total	.18	.55

ANOVA

abs

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.179	2	.090	21.692	.000
Within Groups	1.910	462	.004		
Total	2.090	464			

Robust Tests of Equality of Means

abs

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	24.304	2	397.349	.000

a. Asymptotically F distributed.

Contrast Coefficients

Contrast	typeN		
	1.00	2.00	3.00
1	1	-1-	0
2	1	0	-1-
3	0	1	-1-

Contrast Tests

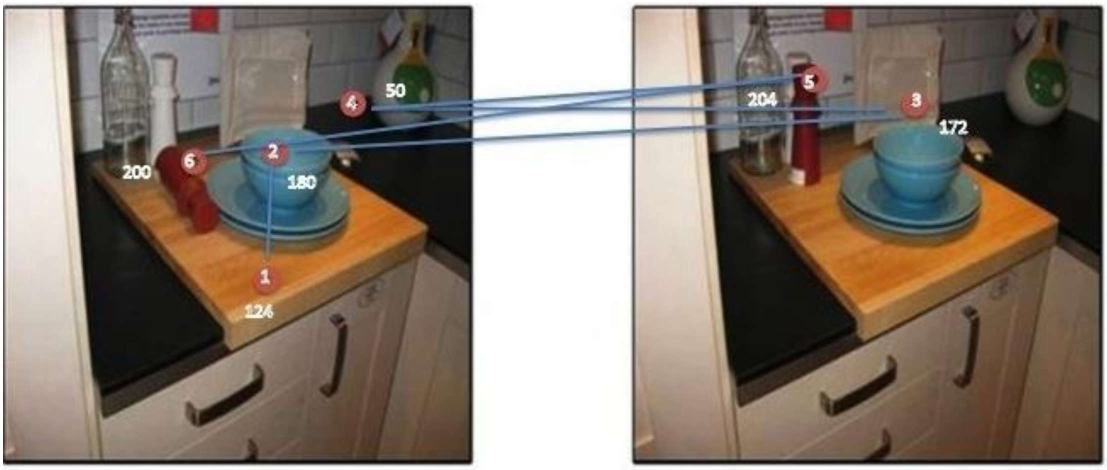
		Contrast	Value of Contrast	Std. Error	t
abs	Assume equal variances	1	-.0459-	.00857	-5.353-
		2	-.0015-	.00750	-.195-
		3	.0444	.00719	6.174
	Does not assume equal variances	1	-.0459-	.00764	-6.001-
		2	-.0015-	.00678	-.216-
		3	.0444	.00729	6.091

Contrast Tests

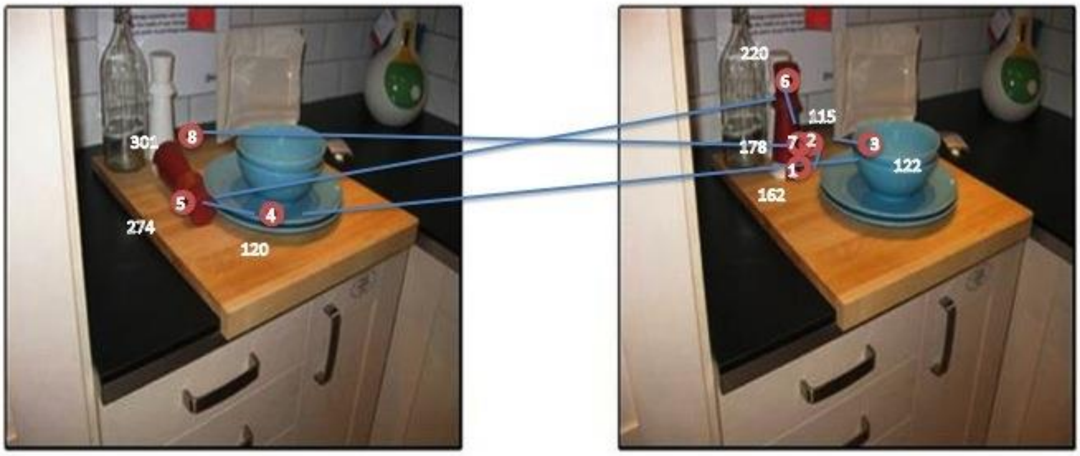
		Contrast	df	Sig. (2-tailed)
abs	Assume equal variances	1	462	.000
		2	462	.845
		3	462	.000
	Does not assume equal variances	1	223.154	.000
		2	264.399	.829
		3	261.744	.000

Appendix D. Examples of the scanpath of a Saudi and a British participants

The scanpath of a British participant:



The scanpath of a Saudi participant:



Appendix E. Pronoun Circling Task: Priming Independent/ Interdependent self

Independent Pronoun Circling Task:

In the paragraph below please circle all the pronouns (e.g. I, Me).

I go to the city often. My anticipation fills me as I see the skyscrapers come into view. I allow myself to explore every corner, never letting an attraction escape me. My voice fills the air and street. I see all the sights, I window shop, and everywhere I go I see my reflection looking back at me in the glass of a hundred windows. At nightfall I linger, my time in the city almost over. When finally I must leave, I do so knowing that I will soon return. The city belongs to me.

Interdependent Pronoun Circling Task:

_In the paragraph below please circle all the pronouns (e.g. We, Us).

We go to the city often. Our anticipation fills us as we see the skyscrapers come into view. We allow ourselves to explore every corner, never letting an attraction escape us. Our voice fills the air and street. We see all the sights, we window shop, and everywhere we go we see our reflection looking back at us in the glass of a hundred windows. At nightfall we linger, our time in the city almost over. When finally we must leave, we do so knowing that we will soon return. The city belongs to us.

Appendix F Singelis (1994) Scale for independent/ interdependent self-construal

This is a questionnaire that measures a variety of feelings and behaviours in various situations. Read each of the following statements as if it referred to you. Indicate your agreement or disagreement with the statement using the following scale:

1 = strongly disagree, 2 = disagree,3 = disagree somewhat, 4 = don't agree or disagree
5 = agree somewhat, 6 = agree, 7 = strongly agree

1- I enjoy being unique and different from others in many respects.

2. I feel comfortable using someone's first name soon after I meet them, even when they are much older than I am.

3. Even when I strongly disagree with group members, I avoid an argument.
4. I have respect for the authority figures with whom I interact.
5. I do my own thing, regardless of what others think.
6. I respect people who are modest about themselves.
7. I feel it is important for me to act as an independent person.
8. I will sacrifice my self-interest for the benefit of the group I am in.
9. I'd rather say "No" directly than risk being misunderstood.
10. Having a lively imagination is important to me.
11. I should take into consideration my parents' advice when making education or career plans.
12. I feel my fate is intertwined with the fate of those around me.
13. I prefer to be direct and forthright when dealing with people I've just met.
14. I feel good when I cooperate with others.
15. I am comfortable with being singled out for praise or rewards.
16. If my brother or sister fails, I feel responsible.
17. I often have the feeling that my relationships with others are more important than my own accomplishments.
18. Speaking up during a class is not a problem for me.
19. I would offer my seat in a bus to my professor.
20. I act the same way no matter who I am with.
21. My happiness depends on the happiness of those around me.
22. I value being in good health above everything.
23. I will stay in a group if they need me, even when I'm not happy with the group.
24. Being able to take care of myself is a primary concern for me.
25. It is important to me to respect decisions made by the group.
26. My personal identity independent of others is very important to me.
27. It is important for me to maintain harmony within my group.
28. I act the same way at home that I do at school.

Scoring and Interpretation

Add the numbers placed before items:
1, 2, 5, 7, 9, 10, 13, 15, 18, 20, 22, 24, 26, and 28
This assesses the strength of the independent self.
Similarly, add the numbers placed before items:
3, 4, 6, 8, 11, 12, 14, 16, 17, 19, 21, 23, 25, and 27
This assesses the strength of the interdependent self.

In each case, total scores can range from 14 to 98, with higher numbers reflecting higher degrees of independence or interdependence.
Singelis' research has indicated that these two aspects of self are separate factors and
Thus do not constitute a continuum.

Source: Singelis, T. (1994). The measurement of independent and interdependent self-construals. *Personality and Social Psychology Bulletin, 20,* 585.

Appendix G. The list of objects used in Experiment 8, Visual Memory Task

- adhesive tape
- aeroplane
- airplane
- almonds
- ambulance
- angle indicator
- apple
- arm chair
- axe
- back back bag
- backpack
- balloon
- ban
- bananas
- basket ball
- bath sponge
- bathtub
- bed
- bench
- bicycle
- billiard ball
- black bag
- black dress
- black skirt
- blackberry
- blackboard
- blanket
- blender
- blue car
- blue skirt
- blueberry
- bobbin
- book
- book case
- bow
- bracelet
- bread
- broom
- bucket

- candle
- capsule
- car
- cardboard box
- carrots
- CD player
- chair
- charger
- cheese
- cherry blossom tree
- chest box
- chest drawers
- child seat
- chocolate bar
- closet door
- cloth pin
- cookie
- coffee machine
- coffee table
- coins
- comb
- compasses
- computer
- crackers
- creb
- cucumber
- cuff link
- cupcake
- curtain
- desk
- dishwasher
- door
- door handle
- door keys
- dress
- drill
- drums
- dustpan
- earrings
- Earphones

- fax
- file
- fire extinguisher
- fireplace
- folder
- football
- fork
- French press
- fruit can
- garden chair
- gas cylinder
- gas pump
- gate
- ginger
- glass
- gloves
- glue stick
- grater
- green cup of coffee
- green pepper
- green plate
- guitar
- gum
- gun
- guitar
- hair band
- hair brush
- hair dryer
- hammer
- hand bag
- hand cream
- hand watch
- hanger
- hat
- headphone
- heater
- helicopter
- helmet
- high heel
- honey
- hovercraft
- ice cream

- kettle
- key car
- keys
- kid's bed
- kite
- Kiwifruit
- knife
- laptop
- ladder
- luggage
- lampshade
- lamp
- laptop
- lemon
- lettuce
- light bulb
- light house
- lighter
- lipstick
- loafer
- lock
- lunch box
- magazines
- markers
- match stick
- matches
- mayonnaise
- men jacket
- men's belt
- metal scissor
- microscope
- microwave
- milk cup
- mirror
- mobile
- motorcycle
- mug
- nail clip
- nail polish
- napkin
- note book
- office chair
- olive oil
- olives
- onion bag

- paint Gallon
- paper puncture
- peanut butter
- pear
- peeler
- pen case
- pencil
- pencil crayons
- pencil sharpene
- perfume
- piano
- picture frame
- pin
- pineapple
- pink purse
- plate
- police car
- pomegranate
- Pomegranate
- potato
- power outlet
- printer
- pumpkin
- puzzle
- Q tips
- radio
- raisin
- range
- razor
- red cup of tea
- red pepper
- red thread
- refrigerator
- remote control
- road
- robe
- rug
- ruler
- sail boat
- salt
- saw
- scarf
- scissor
- screw driver
- sewing machine

bus
calendar
camera

egg
emergency ambulance ca
engagement ring
fan

injection
iron
jeans
ketchup

orange
ottoman
paint
paint brush

shampoo
shaving machin
shell
shower

slide
slippers
soap bar
socks
sofa
sponges
spoon
stairs
stapler
stone
stop watch
strawberry
suitcase
sun flower
sun glasses

swing machine
swing needle
table
tank
taxi

tea pot
telephone
television
tennis shoe
tent
thread ball
teddy bear
tie
tire
tissue box
toast
toaster
tomato
tooth brush
toothpaste
towel
towel hook
train
trash pin
treadmill

tree
trousers
T-shirt
tub
TV screen
umbrella
vacuum
violin
wall watch
wallet
washing machine
wastebasket
watch
water bottle

water heater
water paint
watermelon
weighing device
weight scale

weights

white board
white pillow
window
wire whisk
women jacket
wooden chair
wooden door
wool
yellow flower

Appendix X. Some Photographs from Riyadh & Nottingham Cities