The Role of Language and Culture in Face and Scene Processing and Description Strategies

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Abstract

Face perception is important in a variety of human social interactions, allowing us to keep track of individuals' identities, recognise emotional expressions and intentions and make judgements about variables such as age, ethnicity and health. While early research assumed that face recognition strategies were universal, more recent studies have shown that East Asian and White Caucasian observers use different looking strategies to recognise faces, with East Asian participants focusing more on the centre of the face, which has been interpreted as representing a configural processing strategy, while White Caucasian observers fixate more on the eyes and mouth, which has been interpreted as representing a more featural processing strategy. Debate continues over the reasons behind this difference, with some researchers arguing that it represents an extension of more holistic cognition in the more collectivist East Asian cultures, and more analytic cognition in individualist Western cultures. The Sapir-Whorf hypothesis suggests that cognition is bound by language, and there have been studies showing changes in response patterns in tasks conducted by bilingual participants in their different languages. Others argue that these differences in face processing are driven instead by different salient diagnostic features of faces of different ethnicity. In this thesis, I present the results of five studies examining the role of culture and facial appearance in determining the looking strategy of East Asian and White Caucasian observers.

In Chapter 2, we attempted to use a Navon task to prime featural or configural processing in Malaysian Chinese observers engaged in a face recognition and description task of East Asian and White Caucasian faces. While the Navon task failed to elicit a change in either looking or description strategy, it was noted that the features fixated on most were not the features described most frequently. Further, the race of the face impacted on the looking strategy used to recognise faces, with participants fixating more on Caucasian hair than Asian

hair, suggesting that the different diagnostic features may drive differences in looking strategies. It was also casually observed that observers with stronger Asian accents made more configural descriptions.

In Chapter 3, I investigate the strategies used by Malaysian Chinese and White Caucasian observers when recognising and describing East Asian and White Caucasian faces. A linguistic/cultural priming paradigm was used in an attempt to induce featural or configural processing in observers. In Study 1, the East Asian observers' eye movements were impacted by the race of the faces, making more fixations on Caucasian hair and eyes than on Asian hair and eyes. Again, patterns of looking and description were very different. Also, the description patterns differed by language, with participants making more descriptions of hair when speaking English and more descriptions of noses when speaking Chinese, suggesting that descriptions may be constrained by language. In Study 2, White Austrian Caucasian observers again showed very different description and fixation patterns. Observers again showed different fixation patterns for Asian and Caucasian faces, fixating more on Caucasian hair than Asian hair, suggesting that fixation pattern may be driven by the diagnostic features of the faces. Observers made more descriptions in German than in English, but did not show a difference in the pattern of describing different facial features depending on either the language spoken or the race of face, suggesting that the more similar German and English languages have similar constraints.

Asian observers have been previously shown to direct more attention to contextual information in images of scenes than Caucasian observers, possibly due to a more holistic/configural cognitive style. Since it is known that faces are processed in a different way to other stimuli, in Chapter 4, I report the results of two studies investigating the impact of linguistic/cultural priming on participants' eye movements and descriptions when describing street scenes. The Malaysian Chinese participants made more fixations on, and descriptions of, nonfocal than focal objects in Asian street scenes and when speaking Chinese, but not when describing European scenes in English. The White Austrian Caucasian observers did not show any difference in fixation or description patterns depending on linguistic condition, other than making more descriptions overall in German than in English. This suggests that, in a non-face description task, linguistic/cultural priming was successful in eliciting cultural “frame shifting” in Malaysian Chinese participants speaking English and Chinese, but not in Austrian Caucasian participants speaking the culturally more similar English and German.

We conclude that culture/language does impact on description patterns in face and scene stimuli, possibly reflecting the constraints of different languages. Further, an impact of linguistic/cultural priming was found on fixation patterns in street scene stimuli. However, in face perception tasks, race of face, but not cultural/linguistic condition, impacted on fixation patterns. We conclude that, while language and culture may have an impact on cognition, and place constraints on descriptions, the diagnostic features of faces appear to primarily determine the fixation patterns on face stimuli.

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Chapter 1
General Introduction

A large amount of research has shown that, while people are good at recognising familiar faces, this ability does not generalise well to unfamiliar faces, which are difficult to recognise, both in memory tests (Lindsay et al., 2011) and in face matching tasks (Burton & Jenkins, 2011). The ability to recognise individual faces is particularly crucial in human social interaction. The ability to recognise faces enables us to know with whom we have interacted in social situations (Volstorf, Rieskamp, & Stevens, 2011), and recognise those who have previously cooperated or defected in social interactions (Farelly & Turnbull, 2004).

Besides being able to distinguish one face from another, the ability to describe facial features in sufficient detail to another person is important in social situations, for example, when individuals describe faces to look out for, or when they narrate their experiences to each other. Descriptions allow individuals to share information about others, thereby extending knowledge about individuals' reputations throughout the group and to other social groups (Kniffin & Wilson, 2010; Sommerfeld, Krambeck, Semmann, & Milinski, 2007).

Individuals are better able to distinguish own- than other-race faces, from as young as 9-months old (Pascalis, de Haan, & Nelson, 2002), possibly because we use face recognition strategies that are effective in own-, but not in other-race faces (Blais, Jack, Scheepers, Fiset & Caldara, 2008; Tan, Stephen, Whitehead, & Sheppard, 2012). Indeed, studies have shown that individuals from Asian and Western cultures tend to use different looking strategies when performing face recognition tasks (Blais et al., 2008; Tan et al., 2012).

This thesis aims to investigate whether differences in looking and description patterns are determined by differences in cognitive styles associated with different cultures (i.e. more holistic processing in collectivistic Asian cultures vs more featural processing in individualistic Western cultures), or by individuals learning the best strategies for recognising individual faces based on morphological differences within their own ethnic group. We also investigate the role of using language as a cultural prime, by attempting to induce a shift in individualist or a collectivist thinking in bilinguals, in determining patterns of descriptions of faces and street scenes. We focus on a cross-cultural sample of Malaysian Chinese and Austrian Caucasian participants. In the first part of this chapter, cross-cultural differences in cognition and in face processing styles are discussed. We will then outline the literature on face descriptions, and on using cultural and linguistic priming to induce changes in processing. Lastly, a description of Malaysian culture and the linguistic landscape of the country will be outlined before the hypotheses are presented.

1.1 Face Processing

Two primary mechanisms by which people process the information contained in faces have been proposed: featural processing and configural processing. While featural processing is thought to involve processing and recognising features individually, configural processing (often further split into first- and second-order processing) involves processing and recognising the relationships between features (Blais et al., 2008). Global and holistic processing refer to processing featural and configural information together. In the following sections, the evidence supporting each of these processing styles, including different types of configural processing (Maurer, Le Grand, & Mondloch, 2002; see 1.1.2), is presented.

1.1.1 Featural Processing

One of the first mechanisms that were proposed to explain face perception is called Feature Detection Theory. This theory noted that faces differ from each other on a number of features, such as the eyes, nose, mouth, forehead, etc. It was proposed, therefore, that face recognition operated by learning the appearance of these features individually. Davies et al. (1977) used Photofit kits to test this theory. (Photofit is a type of face reconstruction kit used by the British police in the 1970s, consisting of numerous interchangeable parts of the five facial features: the hair and forehead, the eyes and eyebrows, nose, the mouth and lips, and the chin and cheeks. From these features, a variety of composite faces can be constructed by selecting a sample from each feature, which witnesses can put together to help police depict a suspect.) Participants were presented with faces to learn and were then asked to pick the target face out of a group of distractor faces that differed on a single feature (for example the eyes or the nose). Results showed that participants found it easiest to identify the target face if the eyes were the feature that changed, followed by the mouth and then the nose. It was suggested that different facial features had more value in face recognition than others, for example, the hair being more distinctive because of varied hairstyles and the nose offering little value apart from its position on a face. Davies et al. concluded that individual features are processed separately.

Bradshaw and Wallace (1971) presented participants with pairs of faces that could either be the same or could differ on one, two or more features, and asked them to indicate if they were the same or different. It was found that participants' reaction times became slower, and their accuracy decreased as the number of features that differed between the faces increased. Again, it was concluded that faces are processed featurally, since the features of a face were key to participants' ability to recognise faces accurately.

Ellis et al. (1975b) asked participants to reconstruct Photofit faces (i.e. put together the features of a target Photofit face using a Photofit kit), either from memory or side by side with the original. It was found that some features were more accurately reproduced than others – the forehead was most accurately reproduced, followed by the eyes, mouth, chin and nose. When these reconstructions were presented to different participants, the reconstructions in which more features had been correctly reproduced were identified more accurately. It was concluded that faces are therefore recognised by encoding individual features.

Similar results were found by McKelvie (1976), who found that obscuring the eyes impeded recognition more than obscuring the mouth. Participants were presented with one of these sets of faces across a learning task followed by a recognition task: unmasked faces for both learning and recognition tasks; unmasked faces for learning and either the eyes, nose or mouth masked for recognition; faces with a feature masked for both learning and recognition; faces with a feature masked for learning and then unmasked for recognition. While participants recognised faces just as quickly and as confidently when the nose or mouth were masked, recognition accuracy was shown to be worse when the eyes were obscured, suggesting that the eyes were more important as a cue for recognition than the mouth.

1.1.2 Configural Processing

In the 1980s, however, researchers proposed that faces were processed configurally as well as featurally. While there has been no consensus on the precise definitions of these terms (Maurer et al., 2002; Piepers & Robbins, 2012), configural processing is generally thought to consist of three forms: first-order relations (i.e. eyes above a nose and mouth), second-order relations (i.e. the distance between features), and holistic processing (i.e. combining all the features into a gestalt) (Maurer et al., 2002).

It is important to note, however, that there are significant discrepancies in how different authors use the term *configural processing,* along with disagreements about its importance in face recognition. Maurer et al. (2012) noted that while some authors have restricted the use of the term *configural processing* to one of these types of processing, some authors have used it as a blanket term to refer to all three; or distinguishing between two of the three types of processing (e.g. referring only to second-order relations and holistic processing). Burton, Schweinberger, Jenkins and Kaufmann (2015) further argue that the concept of configural processing is problematic due to a lack of proper definition, and that second-order configural processing in particular is unimportant to familiar face recognition. Wilhelm, Herzmann, Kunina, Danthiir, Schacht, and Sommer (2010) found evidence that the processes used in perceiving faces may be distinct from those used in remembering faces, and argued that both may not be adequately understood in terms of featural and configural processing, with further research necessary to identify other processes contributing to face perception and recognition.

Sergent (1984) used two different paradigms on the same set of stimuli depicting a series of faces constructed from Photofit, in which three characteristics of a face – the eyes and eyebrows, the chin and jaw, and the arrangements of the inner facial features – were manipulated. One of the two paradigms used was a two-choice “same-different” judgement task, in which two faces were presented side by side, measured by accuracy and reaction time; the other paradigm was a dissimilarity judgement task analysed through multidimensional scaling (MDS), in which participants rated how dissimilar each face pair was, on a scale of 1 to 25. Sergent argued that using two paradigms allows the evaluation of the nature of the processes underlying facial discrimination, as well as identification of the relative contribution of each facial feature to the overall face configuration, and determines if facial features are processed independently or interactively with each other. Regression analyses found that the different features contributed interactively to the model predicting recognition accuracy, suggesting that features were processed simultaneously, and in relation to each other. No such effect was seen for inverted faces. Sergent concluded, therefore that both featural and configural processing is used in face recognition, and that inverting faces disrupts first order configural processing, since first order configuration information is changed (i.e. in an inverted face, the eyes are no longer above the nose, which is no longer above the mouth).

Further studies confirmed that configural processing is important in face processing. Tanaka and Farah (1993) trained participants to recognise normal and scrambled faces. They postulated that, if faces are recognised configurally, then individual features should be recognised more effectively when part of a whole face than when presented in isolation or as part of a scrambled face. In addition, there should be a disadvantage for recognising isolated features compared to whole normal faces. The scrambled faces consisted of features of a normal face. Immediately after the learning phase, participants identified facial features presented either in isolation (e.g. “identify Larry’s nose”) or in a complete whole-face, while other facial features were kept constant (see Figure 1.1). Features were found to be recognised more accurately when presented with the whole face, relative to when presented individually or as part of a scrambled face. To control for possible size differences and the unrealistic nature of the scrambled faces, the experiment was replicated with inverted faces, as it was possible that participants' performance may have been affected by these low-level stimulus differences. In the second experiment, half the participants learned a set of upright faces while another half learned a set of inverted faces. After learning, faces in the opposite orientation from the learning task were presented (e.g. upright in the learning phase and inverted in the recognition phase, or vice versa). In the recognition phase, participants identified facial features presented in isolation and in a whole-face context. For example, in the isolated part test condition, they were asked to identify "Larry's nose", whereas in the whole-face condition, they were asked to identify "Larry". The eyes, nose and mouth from each face were presented in the isolated part- and whole-face conditions. Again, more accurate judgements were made when intact whole faces were presented upright in the recognition phase than the part-face stimuli. The whole-part advantage, however, was not shown in the inverted condition. Lastly, images of houses were presented as contrast stimuli, as houses contain internal features (e.g. doors and windows) that share an overall configuration, but do not have the same degree of social significance as faces. No part or whole advantage was found for the house stimuli. Tanaka and Farah suggested that because participants were less accurate at identifying parts of faces presented in isolation, than when presented in a whole face, relative to recognising parts and wholes of other kinds of stimuli, face recognition uses a greater reliance on holistic processing than other types of stimuli.

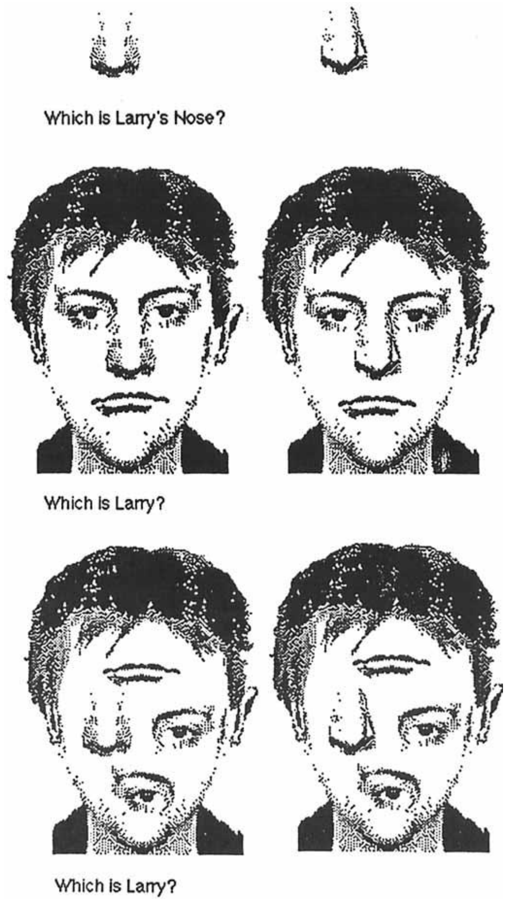


Figure 1.1 Example of isolated part, intact whole face, and scrambled face test items (Tanaka & Farah, 1993).

Another task that aimed to identify configural processing of faces is the composite task. This task involves recognising only the top half of faces, while ignoring the bottom half. If faces are processed configurally, then the ability to recognise only the top half of a face in a composite face made up of the target top half and a distractor lower half (which is therefore processed as a complete face) should be less effective than the same composite face in which configural information is disrupted by making the top and bottom halves misaligned (and is therefore not processed as a complete face). Young, Hellaway & Hay (1987) tested this hypothesis with faces of famous people, and confirmed that participants were more successful at recognising the top half of the face in the misaligned than the aligned condition, suggesting that configural processing plays a role in face perception (see Figure 1.2). This effect has since been replicated in unfamiliar faces (Hole, 1994), own and other race faces (Mondloch, Elms, Maurer, Rhodes, Hayward, Tanaka, & Zhou, 2010).

Figure 1.2 Sample stimuli from Young et al. (1987) to measure holistic processing. Top half of Max Bygrave's face and the bottom half of Lord Snowdon's face in (L) composite and (R) noncomposite arrangements.

Thus far I have discussed two primary mechanisms proposed in the face perception literature: featural and configural processing. Early studies proposing the Feature Detection Theory suggest that features are processed featurally, and that features such as the hair, forehead and eye regions are more important to identification than the nose and mouth regions. More recent studies propose that individuals process faces configurally as well as featurally, but more configurally than featurally. This is supported by several studies successfully replicating the inversion effect, as well as in composite and isolated-part and whole-part tasks in faces.

1.2 Cross-cultural perceptual differences

1.2.1 Holistic/analytic perceptual styles

A large body of research has demonstrated differences in perceptual styles in East Asians and White Caucasians, for example, when describing oneself (Kanagawa, Cross, & Markus, 2001) and when performing cognitive tasks (Kitayama, Duffy, & Kawamura, 2003). While East Asians tend to utilise more configural cognitive processing styles, by relying on relationships between objects and contextual cues, White Caucasians tend to prefer a more featural processing style, by attending to more salient features in a scene. This is thought to relate to the more individualistic cultures of the West compared to the more collectivist cultures of Asia (Nisbett & Miyamoto, 2005).

Nisbett, Peng, Choi and Norenzayan (2001) outlined this divergence between attitudes of the ancient Greeks and Chinese, two significant civilisations distant from one other and both with significant influences on modern civilisations, in explaining phenomena in their environment. Ancient Greek civilisation gave rise to European and post-Colombian American civilisation, and ancient Chinese civilisation gave rise to other East Asian civilisations, including Japan and Korea as well as having influenced South East Asian cultures. Both civilisations relied on different moral codes. The Greeks had a strong sense of personal freedom, and debate was emphasised as an important skill. In China, Confucianism laid out an individual’s obligations to a larger social group or community e.g. between emperor and subject, parent and child, husband and wife, older and younger siblings, and between friend and friend. Essentially, Nisbett et al. (2001) highlighted that Chinese and other East Asian cultures place greater importance on group harmony than the individual, and vice versa in Western cultures.

Following this, Nisbett et al. (2001) described the ancient Greeks as having an *analytic* perceptual style, in which the individual person, and the individual components of cognition are emphasised, while the ancient Chinese are described as having a *holistic* perceptual style, in which the relationships between people, and the relationships between objects are emphasised.

These concepts of *holistic* vs *analytic* processing are broadly analogous to the concepts of *configural* vs *featural* processing discussed in the preceding section, and also to *global* vs *local* processing, as used by other authors (Piepers & Robbins, 2012). While there is disagreement in the literature as to the precise definitions of these terms, in the context of the face perception literature, broadly speaking *holistic*, *configural* and *global* are used to refer to the processing of multiple features simultaneously, including the relationship between the features on the face (Piepers & Robbins, 2012). *Analytic*, *featural* and *local* are used to refer to the processing of facial features as discrete entities. In the current thesis, I will use *configural* (which subsumes first-order, second-order and holistic processing) and *featural* throughout, except when referring specifically to the claims of other authors.

I will now review research from the cognitive psychology literature that addresses these perceptual differences. Ji, Peng and Nisbett (2000) compared the degree of covariation in object pairings, and the confidence in participants' ratings of covariation, between Taiwanese Chinese and Caucasian American participants. Schematic figures such as a light bulb, medal, pointing finger and coin were presented in pairs on a screen. Once a figure on the left-hand side of the screen was presented, participants were asked to predict what would be presented on the right-hand side of the screen, rate the strength of association between the objects on the left and right, and lastly to rate the confidence of their judgement on the strength of association between both objects. The Chinese participants were found to report stronger associations between objects, and were more confident in their ratings, in line with the literature that East Asians' tendency to use holistic processing strategies.

In a subsequent experiment using the classic rod-and-frame apparatus, Ji et al. (2000) presented a square frame containing a rod, both parts of the apparatus were adjustable independently of each other. Chinese and American participants were asked to stop the experimenter from rotating the rod when the rod appeared to be straight. The Chinese participants were found to have a greater reliance on contextual information, when judging if the rod appears to be vertical (i.e. they used the relative orientations of the frame and the rod to determine if the rod was vertical, rather than considering the orientation of the rod independently). American participants made fewer mistakes on the rod-and-frame task, indicating that they were less reliant on contextual information (i.e. they were less influenced by the relative orientations of the rod and frame, relying instead on perception of the rod in isolation) than the Chinese participants who were more reliant on contextual information.

Kitayama et al. (2003) presented Japanese and American participants with a square frame (e.g. 90mm tall), in which a line was drawn. Square frames of various sizes were then presented, and participants were asked to draw a line that was identical to the original line, in either absolute length (e.g. 30mm in length) or relative length (e.g. one third the height of the square) to the surrounding frame. American participants were found to be more accurate in the absolute task; the Japanese participants however, performed better in the relative task, suggesting that the Japanese were paying more attention to the contextual information (the frame) than the Americans. In a second study, a further two groups (Americans living in Japan, and Japanese living in the US) in addition to the earlier demographics were tested to examine how variable and malleable these cultural differences were. Consistent with the literature, the performance of Japanese participants in Japan and American participants in the US reflected typical Asian holistic and Western analytic cognitive styles, respectively. The expatriate participants, however, had at least partly adapted to the perceptual style of the host culture, suggesting that perceptual style could be malleable to a certain extent, suggesting that the cultural environment may explain these cognitive differences. These results could also be interpreted in terms of the visual environment, however. If, for example, city scenes and other aspects of the environment are laid out in such a way as to be more efficiently processed featurally in the US and configurally in Japan, people could learn different processing styles through exposure to these differing visual environments.

Tardif, Gelman and Xu (1999) compared the proportions of nouns and verbs of Mandarin- and English-speaking mothers and their toddlers. Tardif et al. argued that an increased use of verbs in speech, in proportion to nouns, suggests a greater dependence on contextual information, as this highlights the relationships between objects. Language use was measured across three different methods: controlled observations in three different contexts, a vocabulary checklist, and mothers' reporting of their children's "first words". Across all measures, Mandarin-speaking children were found to have relatively more verbs than nouns than English-speaking children. This pattern was also reflected in the mothers' speech, where Mandarin-speaking mothers produced relatively more verbs than the English-speaking mothers, though both groups of mothers produced relatively more verbs than their children. The increased use of verbs relative to nouns suggests a greater emphasis on relationships between objects in speech, consistent with the hypothesis that East Asian cognition is more holistic and context-dependent than Western cognition.

Kanagawa et al (2001) asked Japanese and American participants to describe themselves while alone, and when in the company of peers and experimenters. While the American participants' self-descriptions were relatively unchanged across the experimental conditions, the Japanese participants' self-descriptions were more negative and self-critical in the social conditions, implying that Japanese participants are more cognisant of social context.

Masuda and Nisbett (2001) examined the descriptions of a fish tank scene by Japanese and American participants. Vignettes of big fish swimming in the foreground and against a number of small objects such as smaller fish and water plants in the background were presented. Participants' descriptions were coded by the frequency of featural and configural descriptions. Descriptions of an object's characteristics (e.g. "There is a big fish) were coded as "featural", while descriptions of the relationships between objects (e.g. "A small fish is swimming towards the big fish") were coded as "configural". Japanese participants were found to make more configural descriptions, in which the relationships between objects were emphasised, than American participants who made more featural descriptions of the individual objects.

Overall, then, individuals from more collectivist Asian cultures process a variety of stimuli in a more holistic way that emphasises the relationships between objects, people and concepts, than individuals from more individualistic Western cultures who emphasise the individual.

1.2.2 Culture and looking strategy

Eye-tracking studies in Western samples had previously led to assumptions that people from different cultures employ similar looking strategies for perceiving faces by focusing on each salient feature (eyes, mouth, nose) in turn (Janik, Wellens, Goldberg, & Dell'Osso, 1978). Recent studies have found that cultural preferences for configural/featural processing styles are also reflected in eye movements, with East Asians fixating more at the central region of the face (i.e. the nose region), which has been interpreted as reflecting a more configural processing style, while White Caucasians fixate more on salient features (i.e. the eyes and mouth regions) across different tasks (Blais, Jack, Scheepers, Fiset, & Caldara, 2008). Participants in Blais et al.'s (2008) study learned a series of East Asian and White Caucasian faces displaying either neutral, happy or disgust expressions per race condition. In the following recognition task, they indicated whether a face was familiar or not from a set of novel and previously seen faces from the learning task, and then categorised each face by its respective race. Across each task and race condition, the East Asian participants were found to look primarily at the nose region and the White Caucasians at the eyes and mouth regions, suggesting that East Asians use a more holistic looking strategy, incorporating featural and configural information, and White Caucasians a more featural looking strategy.

Using a similar paradigm to Blais et al.'s (2008) study, Kelly, Jack, Miellet, De Luca, Foreman, and Caldara (2011) found that British-born Chinese, who were raised in Britain but are ethnically Chinese, used both Eastern and Western patterns for looking at faces. Kelly et al. reported that the majority of the British-born Chinese participants used a more "Eastern" looking strategy, and 25% used "Western" strategies. Tan, Stephen, Whitehead, and Sheppard (2012), however, suggested after a reanalysis of Kelly et al.'s data that these participants use an intermediate strategy, rather than either strictly Eastern-typical configural or Western-typical featural strategies. Their examination of the data show that none of the participants showed a bias of over 10% towards either Eastern or Western looking strategies; the bias values were normally distributed (Kolmogorov-Smirnov test $p \geq 0.2$), around a mean bias of just 2.5%

towards an Eastern strategy, not bimodally distributed as would be predicted if participants used distinctly Eastern or Western looking strategies.

Malaysian Chinese, who live in a highly multi-cultural society with strong Western influence, were found to use an intermediate strategy by fixating more on the eyes (suggesting local processing) as well as in the centre of the face (suggesting holistic processing; Blais et al., 2008), suggesting that they have adapted their looking strategy to enable them to extract useful visual information from faces of various ethnic groups in the environment (Tan et al., 2012). This has led to suggestions that people's looking strategies are calibrated during development to adopt the looking strategy that is most effective at differentiating between individual faces in the visual environment (Tan et al., 2012). Their findings are in line with the *facial information hypothesis* that individuals use looking strategies that focus on information-rich areas of the face which are more diagnostic for identifying faces in the visual environment. Accordingly, Malaysian Chinese participants were found to perform equally well at recognising familiar East Asian and White Caucasian faces, but performed significantly less well at recognising the less familiar African faces (Tan et al., 2012).

It is not known if these variations in looking strategies are dependent upon general cognitive differences originating from differing cultural backgrounds outlined above (the *cultural explanation)*, or if individuals adopt their looking strategy to optimise the recognition of faces in their environments through the most diagnostic features of a face (the *facial information hypothesis).*

1.2.3 Own-race bias

Some light may be shed on the ontogeny of cross-cultural differences in face perception by considering the literature on the own-race bias.

Eye-witness misidentification has been recognised as a greater cause of wrongful convictions in the US than all other sources combined (Gross, Jacoby, Matheson, Montgomery & Patil, 2005). According to the Innocence Project (2016), eyewitness misidentification was the leading cause of wrongful convictions, making up more than 70% of the 353 post-conviction DNA exoneration cases (involving 219 African Americans, 106 Caucasians, 26 Latinos and 2 Asian Americans) in the US since 1989, more than all other factors combined. Out of the 70%, 41% of these eyewitness misidentifications involved identification of other-race faces.

It is established that people recognise faces of their own ethnic group better than they recognise faces of other ethnic groups, a phenomenon known as the *own-race bias* or *other-race effect* (Meissner & Bigham, 2001). This phenomenon is seen to appear early in life, with a significant advantage at recognising own-race faces present in nine-month-old infants, but not in three and six month olds. This implies that the strategies used to recognise faces develop over time in response to the faces in the visual environment (Kelly, Quinn, Slater, Lee, Ge, & Pascalis, 2007). However, this process of perceptual narrowing would also be expected by the cultural hypothesis, as children become more enculturated over time.

Kelly, Jack, Miellet, De Luca, Foreman, and Caldara (2011) conducted a face recognition study in British-born Chinese participants. Participants learned a series of East Asian and White Caucasian faces presented in blocks, and then indicated during the recognition phase whether or not the face presented on the screen looked familiar. Results showed that the British-born Chinese participants recognised faces of both East Asians and White Caucasians with equal accuracy and speed, suggesting that familiarity with members of other ethnic groups reduces the effect of the own-race bias.

A similar finding was also found in Malaysian Chinese participants, who live in a multicultural environment and have a high exposure to Western culture in the country's media, history and environment (Tan et al., 2012). Malaysian Chinese participants were presented with East Asian, White Caucasian and African faces during the learning phase and identified if they had seen the faces during the recognition phase. The East Asian and White Caucasian faces were recognised equally accurately, possibly due to increased familiarity with faces of the two ethnic groups, while less-familiar African faces were recognised less successfully.

Training participants to focus on particular regions of the face has been shown to be enhance recognition accuracy (Hills & Lewis, 2006). White Caucasian participants who received feature-critical training to look at the lower facial features of Black African faces performed significantly better on subsequent recognition tasks than White Caucasian participants who did not receive feature-critical training. This finding supports the hypothesis that learning to focus on areas of the face that serve as useful cues to identity for faces of different ethnic groups may be effective in enhancing recognition accuracy, and again provides support for the hypothesis that different perceptual strategies may be optimal for recognising faces of different ethnicities.

Further research has found that own- and other-race faces are processed differently. Michel, Rossion, Han, Chung, and Caldara (2006) used a composite face task to investigate the configural and featural processing of own- and other-race faces. It was found that, while recognition of the upper-half of faces was impeded when disrupted by the bottom-half of a face, this effect was stronger in own-race faces. This suggests that own-race face processing depends more heavily on configural processing, which is disrupted by inversion (Michel et al., 2006).

It appears, then, that there may be differences in face processing of own- and other-race faces based both on the diagnostic features of the different races, and also in that own-race faces depend more heavily on configural processing.

Recent evidence suggests that socio-cognitive motivational biases, contribute to the own-race bias. Hugenberg, Miller and Claypool (2007) investigated the extent to which ORB can be reduced by inducing perceivers to individuate rather than categorise other-race faces. Participants who were warned of ORB prior to encoding, and instructed to individuate out-group members, showed no ORB. A subsequent experiment using more complex stimuli showed that this elimination of the ORB was not merely due to increased motivation to process all stimuli. Hugenberg et al. suggested that by eliciting individuation of out-group members at encoding, the own-race bias can be eliminated. Thus, they suggest that the own-race bias may have a social component, by which individuals tend to classify other-race faces according to race, rather than according to their individual identity. By removing this social-cognitive bias, the ORB was removed.

Goldinger, He and Papesh (2009) used a discrete recognition-memory procedure in which participants viewed Asian and Caucasian faces, under instructions that they were to memorise them for a later test, while their eye movements were recorded. Caucasian participants used different looking strategies on cross-race faces than own-race faces, preferentially looking at different sets of features. Participants made fewer and longer fixations, with larger pupil dilation, relative to own-race faces. The increased effort that is needed to encode other-race faces was suggested to have impeded recognition of other-race faces. Thus Goldinger et al. argue that when participants selectively reduce effort for encoding other-race faces, the own-race bias will be increased, again suggesting that socio-cognitive motivation is important in the production of the ORB.

1.3 Describing faces

While descriptions of faces are ubiquitous in culture, with people describing other individuals in everyday life, in literature (da Soller, 2010), and importantly in eyewitness testimony in criminal cases (Meissner & Brigham, 2001), relatively little research has examined how people describe faces, and even less has examined facial description in cross-cultural context.

The own-race bias is thought to be a significant contributing factor to poor quality eyewitness testimony, with descriptions of faces differing for own- and other-race faces (Ellis, Deregowski, & Shepherd, 1975). White Caucasians made redundant descriptions of Black African faces (such as mentioning black hair and dark eyes, which are predominant in people of Black African descent) (Ellis et al., 1975). Ellis et al. (1975) also found that people of different ethnicities described faces differently. While White Caucasian participants made primarily feature-based descriptions about the colour and appearance of individual features, Black Africans made more configural descriptions, mentioning the shape of the face, size of eyes, position of hair, and appearance of ears. This suggests that people may learn which features are useful to describe in differentiating the faces in the visual environment (iris and hair colour are useful distinguishing features in a White Caucasian population, but not in Black African or most Asian populations, for example).

However, Fallshore and Schooler (1995) compared White Caucasian participants' descriptions of White Caucasian (own-race) and African American (other-race) faces. In experiment 1, they showed that describing faces impaired recognition of own- but not other-race faces. In experiment 2, they showed that participants who were better able to recognise faces made descriptions that were more effective at helping others to correctly match descriptions to faces in other- but not own-race faces. In experiment 3, they showed that this link broke down in inverted own- but not inverted other-race faces. This was interpreted to mean that, since own-race faces are processed more configurally than other race faces (McKone, Brewer, McPherson, Rhodes, & Hayward, 2007), and featural information is more readily described than configural information by white Caucasians, better descriptions enabled better recognition of other-race but not own-race faces (Fallshore & Schooler, 1995).

It is also likely, however, that facial descriptions are limited by the language spoken, and influenced by the culture of the describer.

1.3.1 The role of language and culture on cognition

The Sapir-Whorf Hypothesis, a theory developed by Edward Sapir (1926) and Benjamin Lee Whorf (1956), posits that the properties of a language (e.g. in terms of grammatical structure and vocabulary) strongly influence the thought and behavioural processes of speakers of that language. For instance, through studying the Hopi language, a Native American tribe of the same name, Whorf suggested that the Hopi's terminology for time provided a different understanding of how time worked, distinct from Western conventions.

There is a "strong" and "weak" version of this hypothesis. The "strong" version as initially proposed by Sapir (1926) and Whorf (1956) states that thoughts and actions are strongly bound by the limits of one's native language, and has been criticised since it has been shown that cultures can contain concepts, even when words to describe them are absent. For example, the Hopi tribe of the Amazon lacks many words for time, but maintains a concept of time (Pinker, 1994). The "weak" version, on the other hand, suggests that differences in the structure and syntax of languages influence the way particular cognitive tasks are approached (Boroditsky, 2001; Papafragou, Massey, & Gleitman, 2006; Winawer, Witthoft, Fink, Wu, Wade, & Boroditsky, 2007).

Thus far studies have suggested mixed evidence on the extent of this proposed effect. Winawer et al. (2007) found Russian native speakers to be faster than English native speakers in discriminating between two distinct categories of blue, which have different names in Russian but not in English (*goluboy* for lighter shades of blue and *siniy* for darker shades of blue), than when distinguishing between two colours within the same colour category (e.g. when stimuli pairs were both in lighter blues or both in darker blues). A similar pattern has also been shown in native Greek and native English-speaking participants (Thierry et al., 2009), an effect that has been confirmed by electrophysiological measurements to originate early in processing (Athanasopoulos, Damjanovic, Krajciova, & Sasaki, 2011).

Native Mandarin speakers are thought to perceive time differently than native English speakers, by using both horizontal (*front/back*) and vertical terms (*up/down*) to express time (Boroditsky, 2001). English and Mandarin native speakers were primed with pictures of a scenario, each with a sentence below the picture. Half the sentences were about horizontal spatial relations (e.g. X is *ahead* of Y) and half were about vertical spatial relations (e.g. X is *above* Y); half the statements were true and half were false. Unusually, all participants (English and Mandarin native speakers) in Boroditsky’s study were tested in English, to examine the extent of how strongly native language (Mandarin) impacts on their perception of time. When statements were phrased horizontally, the English native speakers were quicker at identifying “true” statements (e.g. March comes *earlier* than April”) from control false statements than the Mandarin native speakers. However, when the English speakers were briefly trained to think about time in vertical terms, their performance on the horizontal tasks decreased to that of the native Mandarin speakers. This suggests that an individual's native language can influence how one thinks about concepts such as time, though brief training can reverse these differences.

Code-switching, the use of words from two different languages within a single discourse, occurs frequently in bilingual communities (Li, 1996). Previous studies have sought to examine why bilinguals code-switch. Gumperz (1982) postulated a semantic model based on studying the speech patterns of two communities. In a village in India, it was found that most male residents, particularly those who have travelled considerably, speak the village dialect, the regional dialect and standard Hindi, with each of these serving different functions. For example, the village dialect is spoken at home and with other villagers; the regional dialect and Hindi are spoken when conversing with people outside the village. Gumperz (1964) also compared the use of the above languages with the use of standard Bokmal and local Ranamal in a small settlement in Northern Norway. Similarly, the local dialect was used more frequently among neighbours, while the regional dialect was used for "ritual barriers" - barriers of caste, class and village groupings in India, and of academic, administrative or religious setting in Norway.

Intrasentential code-switching, or code-switching within a single sentence, has been found to be used in different contexts, e.g. when the other language is more efficient to convey meaning than in the original language, to convey ingroup/outgroup membership, when conveying high or low status in conversation (Li, 2000).

Similarly, the position of "endpoints" in a sentence appears to have an influence on cognition. In one study, German/English bilingual speakers were shown movie clips of people moving towards a target (intermediate clips). They were then asked whether these intermediate clips were more similar to clips where the person reaches the target (endpoint oriented) or where the person is moving towards a distant target (ongoing oriented). Participants were more likely to indicate that the intermediate clips were more similar to the endpoint oriented clips when speaking German than when speaking English. This is in line with linguistic studies showing that German is a more endpoint-oriented language than English. This suggests that language impacts on how actions are categorised (Athanasoloulos, Bylund, Montero-Melis, Damjanovic, Schartner, Kibbe, Riches, & Thierry, 2015).

In contrast, other authors have argued that differences in descriptions of actions may be attributable to differences in how concepts are expressed in different languages, rather than to influences of language on cognition. Cross-linguistic differences also seem to be reflected in descriptions of motion events, suggesting that the characteristics of a language could impact on how identical visual stimuli are described. When encoding motion events, the way in which English and Greek speakers describe scenes are different (Papafragou, Massey, & Gleitman, 2005). Greek and English are languages originating from individualistic cultures, but are typographically distinct. Monolingual native English- and Greek-speaking children and adults were asked to freely describe a series of photos depicting motion scenes of familiar everyday actions, i.e. with no restrictions of the type of verbal description required. Papafragrou et al. then coded the main verbs in the participants' responses as path-only (e.g. *He entered*; *He went up*), manner-only (e.g. *He's running; He's running quickly*) or mixed (e.g. *He came running; He walked in*) verbs. English speakers were found to use more linguistic information when describing location and motion scenes with increasing age, using both path and manner verbs, than the Greek speakers who more frequently only mentioned path verbs while omitting manner of motion. Papafragou et al. argue that English grammatical rules allow more manner information to be included in a sentence than in Greek grammar.

1.3.2 Culture and descriptions

Further, descriptions have revealed differences in cross-cultural perceptual styles, for instance, in a categorisation task by Ji, Zhang and Nisbett (2004) in which culture affected categorisation independent of the testing language. European Americans, bilingual Chinese/English speakers from Mainland China, and four groups of Chinese people (originating from Mainland China, Taiwan, Hong Kong and Singapore) residing in the US were tested. The bilingual participants from Hong Kong and Singapore were considered as early bilinguals, as English is learned from Kindergarten level and widely used in daily communication; the bilingual participants from Mainland China and Taiwan were considered as late bilinguals, as English is not learned until after Kindergarten level and is rarely spoken out of formal classroom settings. Thus, Ji et al. predicted a stronger language effect to be stronger in the Mainland and Taiwanese Chinese participants than in the Hong Kong and Singaporean Chinese participants. Participants were presented with three sets of words, of which they indicated which two of the three were most closely related and why. Groupings were coded as categorical if they suggested shared features (e.g. *monkey* and *panda*); groupings were coded as relational if they suggested an object-context or subject-context relationship (e.g. *monkey* and *banana*). Participants' explanations were also coded as categorical (e.g. "Monkeys and pandas are both animals") or relational (e.g. "Monkeys eat bananas"). Ji et al. found the bilingual Mainland Chinese in China and the US providing more relational responses in Chinese than in English. On the other hand, responses from Hong Kong and Singaporean Chinese were found to be equally relational when tested in Chinese and English, possibly because of greater exposure to Western culture.

1.3.3 Cultural and linguistic priming

A number of studies have shown that bilingual participants' responses to tasks differ depending on the language spoken, and the cultural prime applied. This provides some support for the Sapir-Whorf hypothesis, which states that cognition is bound by language, and suggests that bilingual individuals "frame-switch" between different cultural and linguistic mindsets (Luna, Ringberg & Peracchio, 2008). For example, Russian and English bicultural participants were shown videos shot in either Kiev (Ukraine) or Ithaca (New York), in which a man sits down very close to a woman on a bench. Participants were grouped into whether they acquired English in a foreign-language classroom (foreign-language users) or in the target language environment (L2 users), and were asked to describe the video in Russian or English (respectively). Individualistic concepts such as personal space and privacy were described more frequently when speaking English than when speaking Russian, suggesting that frame-switching between more individualistic Western and more collectivist Russian cultures was primed by the cultural and linguistic cues.

Similarly, in a study by Marian and Kaushanskaya (2007), Hong Kong Chinese and American English bicultural participants were asked to answer a series of questions in either English or Chinese. The participants were all Mandarin native speakers who had begun learning English at an average age of 11.5 years (*SE* = 0.60), and had been living in an English-speaking country for an average of 5.5 years. They found that the answers given were concordant with the culture of the language spoken. For example, when asked to "name a statue of someone standing with a raised arm while looking into the distance”, participants were more likely to name the Statue of Liberty when speaking English, and to name the Statue of Mao when speaking Chinese. A similar effect was seen when priming Hong Kong Chinese and American bicultural participants with images of Chinese and American culture (such as the Great Wall of China and the US Capitol Building). Participants exhibited more characteristics of individualistic culture when primed with American icons, and more characteristics of collectivist culture when primed with Chinese icons (Hong, Morris, Chiu, & Benet-Martinez, 2000).

Marian and Neisser (2000) found that Russian immigrants to the United States (mean age of immigration to the US = 14.2 years, *SD* = 4.1) made more descriptions of the Russian part of their lives when asked questions in Russian, and more descriptions of the American part of their lives when questioned in English.

It seems, therefore, that cultural and linguistic priming can cause bilingual and bicultural participants to frame switch and adopt the cultural mindset associated with that language and culture. This will be discussed further in Chapter 3.

Further, studies have shown evidence that bilingual participants perceive emotions and personality differently when speaking in their native language/L1 or second language/L2. Using a self-reported Bilingualism and Emotion web-based questionnaire (BEQ, Dewaele & Pavlenko, 2001-2003), Dewaele (2010) examined the frequency of swearing by participants who reported being maximally proficient in their L1 and L2. The questionnaire consisted of Likert-type questions on participants’ language choice for expressing various emotions, code-switching in inner and articulated speech, the use and expression of swearwords, attitudes towards the different languages, communicative language anxiety in the different languages, and open-ended questions on the communication of emotion. Participants consisted of multilinguals having different L1’s and L2’s. L2 was defined in this study as the second language to have been acquired and the age of acquisition ranged from 1 to 41. Despite similar levels of self-reported proficiency and frequency of using their L1 and L2, participants reported swearing more frequently in their L1, and perceived swearwords in their L1 as carrying more emotional weight. Additionally, Dewaele (2008) found that the perceived emotional weight of saying “I love you” as stronger in participants’ L1. In this study, participants were grouped according to their age of acquisition: those who started learning the language between birth and age 2, those who started before puberty (ages 3-12), and those who started as teenagers (age 13 and above). The general frequency for L1 and L2 usage.

The studies in this section have used a range of early and late bilinguals, each with varying definitions of early and late bilinguals. In the current thesis, the bilingual Malaysian participants will have started learning Chinese and English from Kindergarten or primary school. The Austrian Caucasian participants started learning English in school as part of the education system i.e. from age 7. The participants recruited are considered to be fluent in English, as they are assumed to have passed the relevant English-level requirements (minimum IELTS overall score 6.0, which corresponds to a CEFR level of B2) before entering either the University of Nottingham Malaysia Campus or the University of Vienna.

1.4 Malaysian culture

1.4.1 Overview and historical background

As a brief background, Malaysia’s demographic composition consists of three major ethnic groups (50.4% Malay, 23.7% Chinese, and 7.1% Indian), indigenous groups (11%) and other ethnic groups (7.8%), according to the Department of Statistics Malaysia (2011).

Peninsular Malaysia was originally occupied by various indigenous tribes in prehistoric times. Between the 2^{nd} century BC and the early 14^{th} century, merchants from India, China and parts of what is now Indonesia settled in various ports in the west coast of the peninsula. The port of Malacca was founded in the early 15^{th} century, becoming a prominent trading port in the Southeast Asian region. Malacca prospered due in part to its strategic location in the middle of a major shipping route, and diplomatic relations were established between neighbouring countries (e.g. Siam and parts of current Indonesia) as well as China and Japan. These factors brought about the first wave of immigration of Chinese and Indians to Peninsular Malaysia, as well as Arab merchants, who intermarried with the local population, resulting in a large foreign-born population.

The Portuguese and Dutch successfully invaded Malacca in 1511 and 1641, respectively, giving rise to intermarriage between the settlers and the local population to form a sizeable Eurasian community. British colonial rule began from the late 19^{th} century as advisers to Sultans (local heads of state) from nine Malay sultanates of the peninsula. The Sultanates of northern Borneo (i.e. Sabah, Sarawak and Brunei) also became British protectorates soon after. After World War II, Sabah and Sarawak became British Crown colonies.

Especially on the west coast of Peninsular Malaysia, the British brought in indentured labourers from India to work on the rubber plantations. A large wave of Chinese immigrants arrived to work in the growing tin-mining industry. In the present day, a multiethnic and multicultural society has been formed from immigration, and to some extent, intermarriage over the past centuries (Lambert, 2015). The states in Peninsular Malaysia, then known as Malaya, were under colonial British rule from the 19^{th} century until independence was achieved in 1957. Sabah and Sarawak joined

Malaya to form Malaysia in 1963 after a referendum, thus gaining independence from Britain (The Commonwealth Yearbook, 2015).

During British colonial rule, the English language was given importance and subsequently taught as a core subject in all vernacular and national-type schools (Gaudart, 1987). Data from the Department of Immigration reported that expatriates from the United Kingdom consisted of 8.6% of the 19,444 expatriates in the country in 2006, the fourth largest source of expatriates to Malaysia (Kanapathy, 2008). Further, the Malaysian participants in the current thesis were studying at a foreign branch campus of a British university. There are currently nine foreign university branch campuses in Malaysia, out of which eight originate from Anglosphere countries, i.e. four from Australia and four from the United Kingdom (Malaysian Ministry of Higher Education, 2017).

Besides having British lecturers and classmates, many students would also have attended international schools, thus making them more familiar with White Caucasian faces as well as East Asian faces.

Although Malaysia is a multicultural society, it is significantly influenced by Western culture. 86% of films shown in Malaysian cinemas are Western (from the US and EU) while only 14% are local; in comparison, 57% of films shown in East Asian countries such as China and Japan are local (Epstein, 2011).

Hofstede, Hofstede and Minkov (2010) proposed six dimensions of national culture, of which the Individualism subscale has been defined as "the degree of interdependence a society maintains among its members". Lower scores (out of a total score of 100) fall in the collectivist range of the subscale, denoting a higher degree of collectivism in a country, defined by Hofstede et al. as "a close long-term commitment to the "member" group, be that a family, extended family or extended relationships."

Higher scores fall in the individualist range, defined as "a preference for a loosely knit social framework in which individuals are expected to take care of only themselves and their immediate families." Malaysia scored firmly in the collectivist range. For comparison, China has a score of 20, Malaysia 26, Austria 55, the UK 89 and the US 91 (Hofstede, Hofstede, & Minkov, 2010).

1.4.2 Language usage

The usage of the English language in Malaysia as documented in Lowenberg (1991) reflects the importance of the English language from British colonial times and in Malaysian educational policy after gaining independence from the British in 1957. In order to promote racial unity in the newly independent country, the Federal Government adopted *Bahasa Malaysia* as the official language. In the 1960s, the Ministry of Education introduced a policy where all English-medium schools would be converted to Malay-medium schools. While English still remains as a compulsory subject throughout primary to secondary levels of education, its decreased prominence has led to a decline in English proficiency, particularly in rural areas (Lowenberg, 1991).

Code-switching between languages is common (Lowenberg, 1991). Most people speak at least two or three languages, but are not always proficient in all the languages that they speak (Jacobson, 2002). This linguistic diversity is reflected in the culture and even in the urban landscape. Manan, David, Dumanig, & Naqeebullah (2015) used photographic samples of government and private signage from five selected neighbourhoods of Kuala Lumpur which were public and commercial streets in the hub of the city, each occupied by a predominant ethnic group. Business owners (private proprietors) were interviewed on their views on the use of English, Mandarin, Tamil and other minority languages on the signboards. Each language was found to serve a particular purpose on the signboards. Bahasa Malaysia was used for official notices, as it is the language of government. English was used for economic reasons, being the most widely spoken, and Tamil and Mandarin were used for communication with the Indian and Chinese communities.

1.5 Objectives

This thesis presents studies that aim to determine whether the *facial information hypothesis* or the *cultural explanation* (including the Sapir-Whorf hypothesis) better explains the differences in how people from different cultures look at and describe faces and non-face images.

1.5.1 Chapter outline

In Chapter 2, we use a Navon priming paradigm to prime featural or configural processing in Malaysian Chinese participants, and discuss the resultant patterns of description and looking strategies in a face recognition task.

In Chapter 3, we present two studies. The first uses a linguistic/cultural priming paradigm to prime Anglophone (individualist) and Chinese (collectivist) culture in English/Mandarin bilingual participants. We examine the role of this priming and of facial appearance in determining the looking and description strategies in a face description task. The second acts as a comparison study, using a similar linguistic/cultural priming paradigm in German/English (both individualistic cultures) bilingual Austrian Caucasian participants.

In Chapter 4, we present two studies. The first examines the role of English (individualist) and Chinese (collectivist) linguistic/cultural priming in determining the description and looking strategies of bilingual Malaysian Chinese participants describing non-face scenes. In the second, this paradigm is used with English/German bilingual Austrian Caucasians. This also sheds light on the extent to which facial stimuli are unique in how they are processed by comparing these results to those presented in Chapter 3.

In Chapter 5, the implications of this research are discussed.

Chapter 2
Does Navon priming affect face processing strategies?

2.1 Introduction

2.1.1 The role of local/global processing in face perception

While strategies for extracting visual information from faces were previously thought to be similar across races (Janik, Wellens, Goldberg, & Dell'Osso, 1978), recent studies have found differences in the way East Asians and White Caucasians look at faces, with East Asians using a more global processing style and White Caucasians using a more local processing style for faces (Blais, Jack, Scheepers, Fiset, Caldara, 2008; Jack, Blais, Scheepers, Schyns, & Caldara, 2009) and objects (Kelly, Miellet, & Caldara, 2010).

Blais et al. (2008) conducted a study on East Asian and White Caucasian participants' eye movements when looking at own- and other-race faces. Participants first learned a series of faces displaying either neutral, happy or disgust expressions per race condition. After a brief pause, they then indicated if a face was familiar or not from a series of new and previously shown photos during the recognition task. Lastly, they were asked to categorise each face by its respective race. Results showed that across each task and race condition, East Asian participants focused primarily on the nose region, which was interpreted to be indicative of a more global processing style, while White Caucasian participants used a triangular viewing pattern focusing on the eyes and mouth, which was interpreted as indicative of a more local processing style (see Figure 2.1).

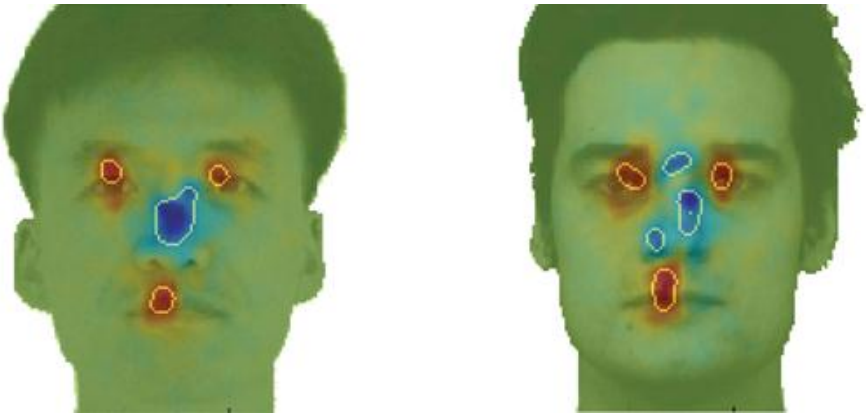


Figure 2.1 Areas in blue show locations where East Asians looked more frequently; areas in red show locations where White Caucasians looked more frequently (Blais et al., 2008).

Individuals who have been raised in a multicultural environment may adapt to their environment by using a mixture of these two distinct strategies. Malaysia is a multicultural country consisting of three major ethnic groups (Malay, Chinese and Indian) as well as other ethnic minorities, and with significant Western influence from British colonisation and mass media. Malaysian Chinese participants have been found use an intermediate looking strategy when recognising faces, focusing more on the eyes and nose (Tan, Stephen, Whitehead, & Sheppard, 2012).

Using a similar procedure to Blais et al. (2008), Malaysian Chinese participants were asked to rate the attractiveness of East Asian, White Caucasian and African faces. After filling in a questionnaire as a distractor task, participants were presented with a series of faces comprising the old and new faces, and indicated whether they had previously seen the face on the screen. Results revealed that Malaysian Chinese used the same intermediate strategy across all tasks and faces, using a smaller triangular pattern alternating between the eyes and nose (see Figure 2.2). Thus, Tan et al. (2012)

suggested that Malaysian Chinese have adapted to a strategy that enables them to extract useful visual information from different races of faces that they are familiar with.

Figure 2.2 Areas in red show locations where Malaysian Chinese participants looked more frequently (Tan et al., 2012).

Kelly et al. (2011) found that British-born Chinese, who are ethnically Chinese but raised in Britain, showed a divide, with some participants using an Eastern looking strategy, while others used a Western looking strategy. Kelly et al. compared participants' looking strategy to the patterns found in Blais et al. (2008), and found that a majority (75%) of the participants used an "Eastern" strategy and the other 25% used a "Western" strategy, thus showing an influence of both cultures. However, a reanalysis of the data by Tan et al. (2012) suggested that the data showed an intermediate strategy (eyes and nose) was used, rather than different participants' eye movements falling into either category, as none of the 20 participants showed bias values of over 10% towards either strategy, and the distribution of bias values was unimodal and distributed around zero.

2.1.2 The role of local/global processing in recognition accuracy

Studies have documented the advantage of global or holistic processing over featural processing in recognising target stimuli accurately. Implementing a Navon letter identification task (Navon, 1977) has been shown to be effective in enhancing recognition accuracy in White Caucasian participants who focused on the large global letters (Macrae & Lewis, 2002), and reducing recognition accuracy in participants presented with the local version of the Navon task (identifying the small letters). McKone et al. (2010) presented the first study to compare local-global processing using Navon letters on East Asians and White Caucasians, in which the East Asian participants showed a significant global advantage in reaction time and hemispheric differences relative to the White Caucasians' performance. Navon letters (Navon, 1977), large letters made up of small letters (e.g. a large 'S' made of small K's), were used to study local and global processing. A Navon letter identification task would typically involve participants being presented with large letters made up of small letters and identifying either the small letters ('local' condition) or the large 'global' letter.

The effects of the Navon letter identification task (Navon, 1977) in inducing local or global processing orientation has been widely studied. Macrae and Lewis (2002) examined the effects of the Navon task on influencing recognition accuracy. In this study, participants watched a 30-second video clip of a simulated bank robbery, followed by a 10-minute Navon letter identification task. Participants who were in the global condition reported the identity of the large letters to the experimenter, while participants in the local condition reported the identity of the small letters. Control participants read a novel for the same duration. Lastly, they identified the face of the "robber" from a line-up of eight similar male faces. Results showed that participants in the global condition performed significantly better on recognition accuracy than the control condition, and those in the local condition performed significantly worse than the control condition.

Evidence of global processing being more advantageous in recognition accuracy has also been shown in an eyewitness recognition task following a Navon task (Darling, Martin, Hellman, & Memon, 2009), suggesting that participants in which global processing has been induced (i.e. after having completed the global condition of a Navon task) might make better eyewitnesses than those with a relative local processing bias.

It has also been shown in the face processing literature that holistic processing is increased when looking at and identifying same-race faces (Baudouin, Chambon, & Tiberghien, 2009; Michel et al., 2006). However, evidence to the contrary has also been found. Using a composite face effect (CFE) test, in which participants ignored one half of a composite face, identification accuracy was not significantly improved or impaired, thus suggesting that holistic processing might not always enhance recognition accuracy for faces (Konar, Bennett, & Sekuler, 2010).

Michel, Rossion, Han, Chung, and Caldara (2006) found that own-race faces were processed more holistically than other-race faces. Using a composite-face task (in which participants are asked to recognise just the upper half of the face, while the lower half may or may not match, and may be presented correctly aligned with the top half, or misaligned), participants had greater difficulty recognising the upper halves of same-race faces compared to other-race faces. Thus, Michel et al. suggested that increased holistic processing may be the reason for better recognition among own-race faces than other-race faces. However, familiarity training has been shown to increase the level of holistic processing in other-race faces (McKone et al., 2007).

While the Navon task has been shown to enhance or impair recognition accuracy in subsequent trials, it is not known whether eye movements will be affected. We predict that if the Navon letter identification task has an effect on altering looking strategies, participants in the local condition will exhibit a looking strategy that has been proposed to reflect more local processing, with more or longer fixations on the eyes and mouth area, while those in the global condition will exhibit a looking strategy associated with more global processing, with more or longer fixations on the central area of the face (Blais et al., 2008). While it has been shown that training White Caucasian participants (who tend to use a more local processing strategy) to adopt a global processing orientation using a Navon task increases recognition accuracy relative to local processing (Macrae & Lewis, 2002), it is not known if the Navon task will produce a similar effect when participants from a multi-cultural environment identify East Asian and White Caucasian faces.

While effects of the Navon task on face recognition performance has been shown in White Caucasian samples, it is not known if a similar result can be observed in Malaysian Chinese who use an intermediate strategy.

2.1.3 Verbal description of faces

The ability to describe is an important part of social interaction, for example, when individuals relate their own experiences to each other. Describing faces or scenes also has important consequences in eyewitness testimony because the information can provide crucial leads to identifying a potential suspect, and also when describing people to look for or talk to in day-to-day interactions. Research on qualitative verbal description of faces, however, is surprisingly limited (Ellis, Deregowski, & Shepherd, 1975).

Ellis et al. (1975) compared descriptions of faces between White Caucasian and Black African faces. White Caucasian and Black African participants were asked to describe a total of 16 photographs of faces, divided equally by ethnic group and gender. Participants were asked to imagine that they had to instruct someone to meet up with a friend at the train station in their native language (Bukusu for the African participants and English for the Caucasian participants). The frequencies in which facial features were mentioned were then recorded. Black African participants were found to use significantly more configural descriptions for the White and Black faces, such as size and whites of eyes, position of hair and face outline; on the other hand, White Caucasian participants were found to use significantly more featural descriptions for both White and Black faces, such as iris colour, hair colour and hair texture. Since most Black Africans have dark-coloured irises and hair and White Caucasians differ in iris and hair colour, Ellis et al. suggested that that people describe facial features in a way that would be more useful to discriminate one face from another in their own ethnic group.

Thus far, there has been no research on verbal description of faces on East Asians, in which a large majority of the population have dark-coloured hair and eyes. Therefore, in line with previous research that East Asians perceive the environment in a holistic manner, relying on relationships among objects (Nisbett & Miyamoto, 2005), it is predicted that East Asians would tend to use more global descriptions when describing faces.

However, as Malaysia is made up of a multicultural population, Malaysian Chinese may adopt an intermediate strategy of describing faces, or employ different strategies when describing East Asian and White Caucasian faces due to the differences in facial features of both racial groups. We predict similar results to Ellis et al. (1975), whereby Malaysian Chinese participants would use more global descriptions when describing an East Asian face and more local descriptions when describing a White Caucasian face.

A study by Johansson, Holsanova, and Holmqvist (2006) examined how people described objects verbally in relation to their eye movements when visualising a scene. Eye movements of participants reflected the positions of objects while they were listening to a spoken description; similar eye movements were also elicited when the same scene description was retold from memory. Thus, eye movements and verbal descriptions of a face are predicted to follow similar patterns because both are focused upon during memory encoding.

As verbal description and fixation pattern are reflections of an individual’s attentional capture (Johansson et al., 2006), we predict that people would use similar perceptual strategies; features that give the most cues to discrimination (i.e. the eyes and nose for Malaysian Chinese) should therefore be fixated on for more times or longer periods of time. However, we are unaware of any previous studies comparing eye movements and verbal descriptions of faces. Therefore, whether people do use similar strategies (e.g. having higher means in the same features across both tasks) when fixating on and describing faces is of particular interest.

2.1.4 Aims and hypotheses

While much research has been reported on the effects of the Navon letter identification task (Navon, 1977), there remains a dearth of literature on the effect of the Navon task on enhancing recognition accuracy in East Asian participants. Similarly, little is known about the effects of the Navon task on eye movements in subsequent face recognition tasks.

In the present study, we use a similar procedure to Macrae and Lewis (2002), using Navon letters (Navon, 1977) to elicit local or global processing in a sample of Malaysian Chinese participants. As Malaysian Chinese tend to use an intermediate looking strategy (Tan et al., 2012), it would be interesting to examine if the Navon task could induce a shift towards a more local or more global processing style of eye movements, and whether recognition accuracy of East Asian and White Caucasian faces in Malaysian Chinese will be enhanced or impaired.

Following Ellis et al.'s (1975) findings that people describe facial features providing the most useful cues to discrimination within their own ethnic group, we aim to examine if there are differences in the way Malaysian Chinese participants describe East Asian and White Caucasian faces. We also sought to investigate if there is a similar pattern between looking strategy and verbal description of faces.

As 'hair' has been shown to provide useful cues of discrimination in Ellis et al. (1975), we will include hair as an additional area of interest (AOI) in the eye-tracking analysis in addition to the three AOIs in Tan et al. (2012) to be able to make parallel comparisons between looking strategy and description frequencies between the features.

This study will include a verbal description task after the face learning task and before the Navon task to allow participants to describe what they had remembered from the video.

We hypothesise that:

1. Participants in the Global condition will have significantly better recognition accuracy for the EA and WC faces, compared to those in the Local condition.
2. Participants in the Global condition will focus more or longer at the nose region, while participants in the Local condition will focus more on the eyes and mouth.
3. Malaysian Chinese participants will adapt their looking strategy to the race of the face they are looking at.
4. Malaysian Chinese participants will use more global descriptions when describing the EA face, and more local descriptions when describing the WC face.

5. Participants will use a similar pattern when looking at and describing faces.

2.2 Methods

2.2.1 Participants

Participants consisted of 39 Malaysian Chinese (20 males, 19 females, mean age 20.90 years) who were studying at the University of Nottingham Malaysia Campus. Eighteen (46.2%) of them reported speaking English as their main or native language, while the remainder (53.8%) reported speaking Chinese as their main or native language. Participants also gave a self-rating of their proficiency in spoken English, as verbal description of faces was required as part of the experimental procedure (mean rating 6.69/10.00, SD = 1.56). All participants reported normal or corrected-to-normal vision, and received either course credit or RM5 for their participation. All work was approved by the University of Nottingham Malaysia Campus ethics committee.

2.2.2 Materials

2.2.2.1 Eye-tracking

A Tobii T60 on-screen remote eye-tracking system was used to record eye movement data through an infra-red camera integrated to the lower part of the 17in TFT monitor. The eye tracker has a high accuracy (0.5°) and drift compensation (less than 0.3°) and performs binocular tracking at a data sampling rate of 60Hz. This non-intrusive eye tracker allows for large freedom of head movement, thus allowing participants to behave naturally without any visible or moving tracking device which may affect them.

A calibration procedure as implemented in the Tobii Studio 2.3 software preceded each task (with the exception of the Navon task) to ensure accurate tracking of eye gaze. Once participants' eyes are detected by the infrared camera, shown as two moving dots on the interface dialogue box, a standard nine-point calibration procedure began to determine the direction of participants' eye gaze.

2.2.2.2 Video stimuli

Three White Caucasian and three Malaysian Chinese males were recruited from the University of Nottingham Malaysia Campus, selected following these criteria: no facial hair, no prominent marks or facial features, and no tattoos or piercings. We also avoided using people who were particularly distinctive looking, in order to avoid recognition being easier than usual. There was one pool player of each ethnic group (1 EA, 1 WC) with two onlookers (2 EA, 2 WC) of each race. While the pool players were playing, the onlookers were instructed to act naturally, like how they would normally watch a game of pool.

A full game was filmed at a pool table on campus using a Panasonic HDC-TM300 high-definition video camera, and then edited to one minute using Windows Live Movie Maker to show equal exposure of both the EA and WC pool players (approximately 36 seconds per player, with equal numbers of turns each). The final, edited video had a duration of 1 minute and 10 seconds. See Figure 2.3.

Figure 2.3 Screen shot from the pool game video. From left to right: WC pool player, WC onlookers, EA onlookers, EA pool player.

2.2.2.3 Photographic stimuli

The photo stimuli consisted of 10 male EA and 10 male WC faces, two of which were the two pool players, photographed in a lighting booth painted with Munsell N5 neutral grey paint and illuminated with d65 fluorescent tubes, in high-frequency fixtures to reduce the effects of flicker (Verivide, UK). Apart from the pool players' photos, the East Asian and White Caucasian stimuli were obtained from the University of St Andrews, UK under identical conditions. All images were colour-calibrated after Stephen, Coetzee, Law Smith, & Perrett (2009) to ensure that participants could not identify faces using simple colour matching. The background was edited using GIMP 2 photo manipulation software to a uniform grey. The images were aligned on the eyes' position using PsychoMorph software (Tiddeman & Perrett, 2001) and were 486 x 600 pixels in size.

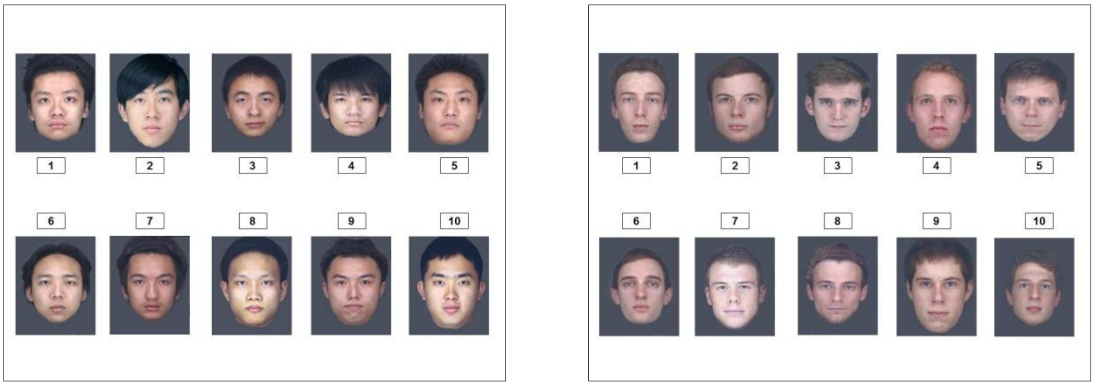
2.2.2.4 Navon letters

The four types of Navon letters (Navon, 1977) used in this experiment consisted of two types of conflicting letters (small H's, large S; small S's, large H) and two types of congruent letters (small H's, large H; small S's, large S). All the letters had a size of 186 x 186 pixels. See Figure 2.4.

Figure 2.4 Navon letters (Navon, 1977).

2.2.2.5 Line-up

Twenty faces (10 EA, 10 WC) were placed in line-up slides in pseudorandom order. Each line-up consisted of 10 faces arranged in two rows. The target face was placed in different positions on each of the ten slides, with the other nine faces arranged in random order. Above each face was a number indicating ‘1’ to ‘10’. Each of the line-up slides were 960 x 720 pixels in size. See Figure 2.5.



(a) EA faces **(b)** WC faces

Figure 2.5 Line-ups used in the recognition task.

2.2.3 Procedure

The experimental procedure consisted of three parts: the learning task, the Navon letter identification task, and the recognition and description tasks.

2.2.3.1 Learning

Participants were tested individually, and were randomly assigned into either the Local or the Global condition. The experiment consisted of three parts: the learning task, the Navon letter identification task, and the recognition and description task. During the learning task, a 1m10s video of a pool game was presented on a Tobii T60 eye-tracker. Participants were instructed to watch the video carefully, as questions will be asked later. After the video had ended, participants were asked to describe the face of both the EA and WC pool players individually for one minute per face, as though they were describing the person to the police.

2.2.3.2 Navon letter identification task

Participants focused on either small letters (Local condition) or large letters (Global condition) for a 7-minute duration. Participants in the Local condition were instructed to focus on the small letters that made up the large letter, e.g. "press '1' if the small letters are 'S', press '9' if the small letters are 'H'. A fixation cross preceded each letter in the middle of the screen for 500ms, followed by a Navon letter for 500ms seconds, and a mask for 500 ms. All letters were presented randomly, with a total of 120 trials. The letters were presented on E-Prime 2.0 Professional with a screen resolution of 1280 x 1024 pixels.

2.2.3.3 Recognition and description

Participants were shown a slide show of 20 faces (10 EA, 10 WC) presented randomly one at a time on a Tobii T60 eye tracker. A fixation cross preceded each of the faces for 1 second, before the faces were presented in the middle of the screen for 5 seconds per face (Tan et al., 2012). Participants were instructed to look at the faces and informed that they will need to identify the two pool players' out of a line-up. The line-up slides were then presented and participants clicked on the face that they thought was the pool player in the video. No time limit was given for the recognition task. In the final description task, participants were asked to describe the EA and WC faces (presented on the screen) for one-minute each in as much detail as possible, as though they were describing to the police.

Finally, participants indicated if they "knew the pool players in real life" or "have seen the pool players before" and were thanked and debriefed. See Figure 2.6 for a summary of the experimental procedures.

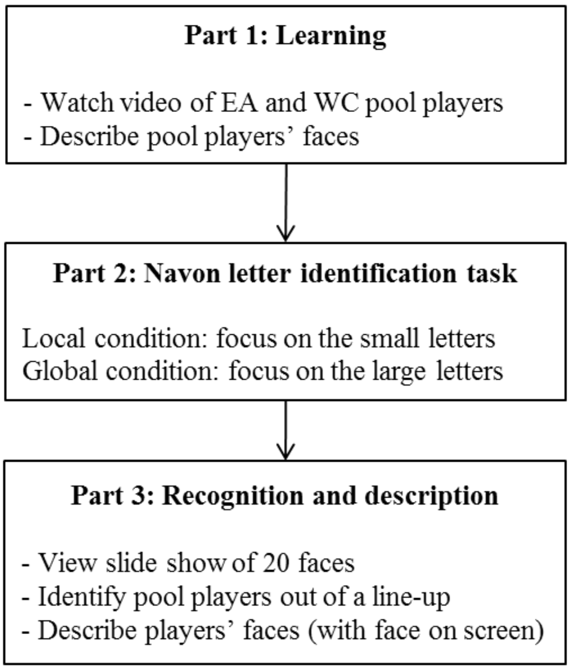


Figure 2.6 Summary of experimental procedures

2.2.4 Data analysis

2.2.4.1 Eye-tracking

The data was processed in Tobii Studio software. Areas of interest (AOI's) were defined on the faces (Hair, Eyes, Nose and Mouth; see Figure 2.7) after Tan et al. (2012). The Velocity Threshold (I-VT) fixation filter from Tobii Studio detects the eyes' angular velocity (30°/second) and discards fixations that are less than 60ms (Olsen, 2012). Samples that are of the same or higher velocity of this threshold are classified as belonging to a saccade (Olsen, 2012).

Participants' data were excluded from analysis if they reported knowing either pool player in real life. Data was excluded from eye-tracking analyses if sampling rate was below 50% for eye tracking data. Based on these criteria, 12 participants were excluded from the analysis: eight (four males, four females) for knowing one of the pool players in real life, and five (four males, one female) for sampling rates lower than 50%.

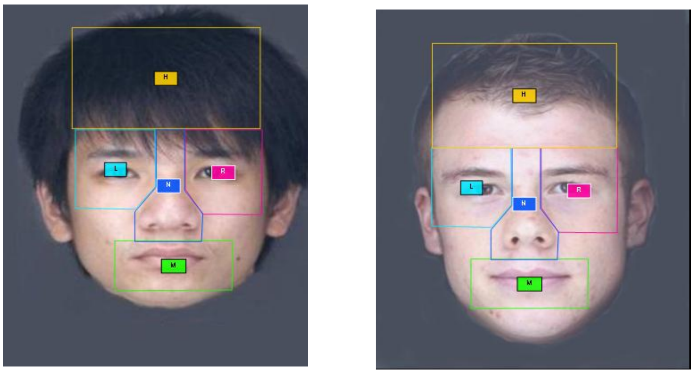
.

Figure 2.7 Predetermined areas of interest (AOI): Hair, Eyes, Nose, and Mouth.

2.2.4.2 Verbal descriptions

The face was divided into four regions according to the AOIs depicted in Figure 2.7, i.e. the Hair, Eyes, Nose and Mouth regions. The description component was further divided into *featural* and *configural* processing orientations. ‘Featural’ descriptions were operationally defined as ‘descriptions about a particular feature of the face’, and ‘Configural’ descriptions were operationally defined as ‘descriptions about the relationship between two or more features, the position of a particular feature in relation to the face, or general impressions of the feature’. See Table 2.1 for a summary of the coding rules.

Table 2.1
Guidelines for coding verbal descriptions

	Description type	
Facial feature	Featural	Configural
Hair and forehead	Hair: hairstyle, colour, length Forehead: width	Comparison to other features Relationship between features*
Eye region	Eyes: colour, size, shape, tired Eyebrows: thickness, colour Spectacles/no spectacles	Eyes: distance apart, symmetry Looks: nice eyes Relationship between features*
Nose region	Size, nostril size, width	Position**, symmetry
Mouth region	Lips: colour, size, shape	Smiling, frowning

Moustache/no moustache

Note:
* Two or more features mentioned within the same description (e.g. “fringes extend over eyes”, “eye brows extend over eyes”, etc.
** Position in relation to the face (e.g. “in the middle of the face”).
Descriptions of the pool game and of features not within the AOIs were excluded.

Inter-coder reliability. Three independent raters who were blind to the hypotheses were recruited to code the verbal descriptions following the rules described above. The raters were asked to replay recordings in Tobii Studio, and code the participants’ descriptions from the first and third task into categories following the rules shown in Table 2.2. Data from the three raters were then used to obtain a Cronbach’s α for each rating category (see Table 2.2). The mean Cronbach’s α for featural and configural description was 0.93 and 0.74 respectively, indicating high inter-coder reliability on all but one category, ‘WC Hair Global’.

Table 2.2
Cronbach α by rating category

Feature	Cronbach α	
	Local	Global
East Asian (EA)		
Hair	0.923	0.854
Eyes	0.938	0.802
Nose	0.954	0.727
Mouth	0.932	0.840
White Caucasian (WC)		
Hair	0.910	0.338
Eyes	0.929	0.758
Nose	0.944	0.817
Mouth	0.919	0.824

For the analysis, the number of descriptions from the learning phase (i.e. without faces on the screen) and the recognition and description phase (i.e. with faces on the screen) were summed.

2.3 Results

2.3.1 Recognition accuracy

72.1% of participants correctly identified the Asian pool player and 58.2% correctly identified the Caucasian pool player, out of a lineup of 10 faces each.

Tests of normality indicated that assumptions of normality were violated, as assessed by Shapiro-Wilk's test ($p < .001$). Eight participants who recognised either of the pool players in real life were excluded from the analysis. A Wilcoxon Signed Ranks Test against a test value of 0.1 showed that participants recognised both the Asian, $Z = 5.02$, $p < .001$, and the Caucasian pool player, $Z = 3.77$, $p < .001$, significantly better than chance.

Pearson's χ^2 tests found no significant difference in recognition accuracy between global and local conditions for East Asian ($\chi^2 = 2.23$, $p = .327$, $\Phi = .19$) or White Caucasian ($\chi^2 = 1.46$, $p = .482$, $\Phi = .16$) faces. McNemar's test was used to determine whether there was a significant difference in the recognition accuracy for the Asian and Caucasian pool players. This test was not significant, $p = .210$.

2.3.2 Eye tracking

2.3.2.1 Fixation Count

As the Fixation Count data was not normally distributed, the data was normalised using a square root transformation. However, the graphs below show untransformed values for easier interpretation.

A 2 (race of face: East Asian [EA] or White Caucasian [WC]) x 4 (feature: hair, eye, nose or mouth) x 2 (Navon condition: local or global) mixed ANOVA was conducted on the total fixations falling on the hair (estimated marginal means mean $\pm$ S.E. = 4.418$\pm$0.255), eyes (6.372$\pm$0.243), nose (6.356$\pm$0.217) and mouth (3.167$\pm$0.174) regions for all participants.

A main effect of feature, $F(2.55, 94.43) = 50.43$, $p < .001$, $\eta_p^2 = .58$ was found. Bonferroni-corrected pairwise comparisons indicated more fixations on the eyes than hair (mean difference = 1.95, $p < .001$), eyes than mouth (mean difference = 3.206; $p < .001$), nose than hair (mean difference = 1.938; $p < .001$), nose than mouth (mean difference = 3.19, $p < .001$), and hair than mouth (mean difference = 1.252; $p = 0.001$). There was no significant difference between the total number of fixations on the eyes and nose (mean difference = 0.016; $p = 1.000$). In summary, participants fixated more frequently on the eyes and nose, followed by the hair, and then the mouth.

There was a two-way interaction effect between race of face and feature, $F(2.29, 111) = 18.20$, $p < .001$, $\eta_p^2 = .33$. Paired sample t-tests showed that participants looked more at the hair for WC faces than for EA faces, $t(38) = -3.945$, $p < .001$. Participants fixated on the eyes ($t(38) = 2.535$; $p = 0.015$), nose ($t(38) = 3.743$; $p = 0.001$) and mouth ($t(38) = 3.656$; $p = 0.001$) more frequently for EA than for WC faces. See Figure 2.8.

No significant main effect was found for Navon condition, $F(1, 37) = .35$, $p = .556$, $\eta_p^2 = .01$. The interactions of feature and Navon condition, $F(3, 111) = .74$, $p = .531$, $\eta_p^2 = .02$ and race of face, feature and Navon condition, $F(3, 111) = 1.29$, $p = .280$, $\eta_p^2 = .03$, were not significant. Thus, we did not see an impact of Navon condition on looking strategy.

The main effect of race of face, $F(1, 37) = 3.06$, $p = .089$, $\eta_p^2 = .08$ and the interaction of race of face and Navon condition, $F(1, 37) = 2.29$, $p = .139$, $\eta_p^2 = .06$ were also not significant.

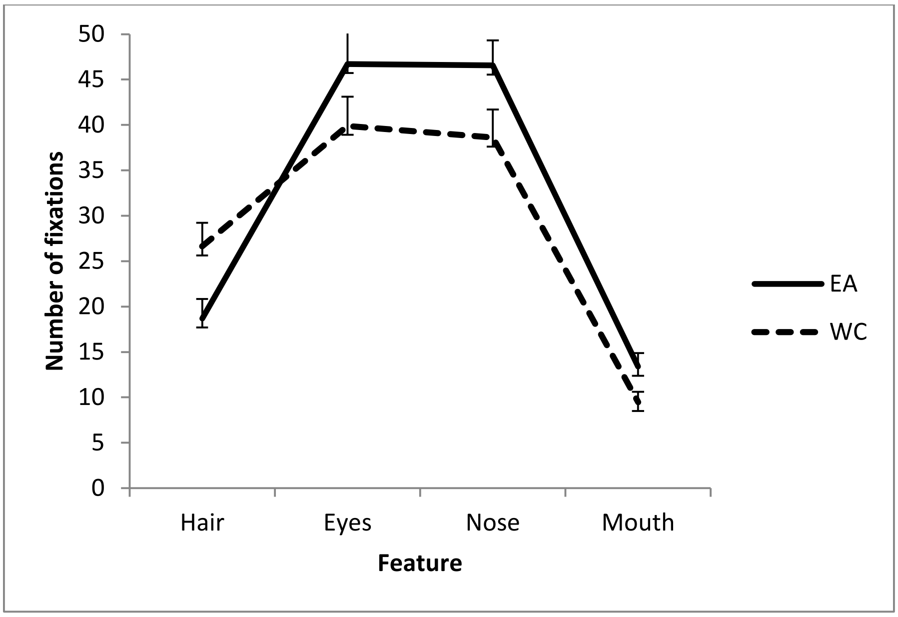


Figure 2.8 Interaction between Race of Face and Feature for total number of fixations landing on the hair, eyes, nose and mouth. Error bars report standard errors of mean.

2.3.2.2 Fixation Duration

As the Fixation Duration data was not normally distributed, the data was normalised using a square root transformation. A 2 (race of face: East Asian [EA] or White Caucasian [WC]) x 4 (feature: hair, eye, nose or mouth) x 2 (Navon condition: local or global) mixed ANOVA was conducted on the total durations falling on the hair (estimated marginal mean±s.e.=2.664±0.123 seconds), eyes (3.615±0.163), nose (3.608±0.162) and mouth (1.614±0.115) regions for all participants.

A main effect of feature, $F(3,111) = 46.86$; $p < .001$, $\eta_p^2 = .56$ was found. Bonferroni-corrected pairwise comparisons showed longer fixations on the eyes than hair (mean difference = .95, $p < .001$), eyes than mouth (mean difference = 2.00; $p < .001$), nose than hair (mean difference = 0.94; $p < .001$), nose than mouth (mean difference = 1.99, $p < .001$), and hair than mouth (mean difference = 1.05; $p = 0.001$). There was no significant difference between the total duration of fixations on the eyes and nose (mean difference = 0.007; $p = 1.000$). In summary, participants fixated for longer on the eyes and nose, followed by the hair, and then the mouth.

There was a significant two-way interaction between race of face and feature, $F(3,111) = 7.75$, $p < .001$, $\eta_p^2 = .17$. Paired-samples t-tests showed that participants looked for longer duration at the eyes ($t(38) = -2.50$; $p = 0.017$) and nose ($t(38) = 3.78$; $p = 0.001$) in EA faces, while a non-significant trend suggested participants may look longer at WC than EA hair ($t(38) = -1.82$; $p = 0.077$). No difference was found in the total fixation duration on EA or WC mouths ($t(38) = -0.21$; $p = 0.835$).

No significant main effect was found for Navon condition, $F(1, 37) = .09$, $p = .768$, $\eta_p^2 = .00$. The interactions of feature and Navon condition, $F(3, 111) = 1.14$, p $= .337$, $\eta_p^2 = .03$ and race of face, feature and Navon condition, $F(3, 111) = .39$, $p = .759$, $\eta_p^2 = .01$, were not significant. Thus, we did not see an impact of Navon condition on looking strategy. See Figure 2.9.

The main effect of race of face, $F(1, 37) = 2.29$, $p = .139$, $\eta_p^2 = .06$ and the interaction of race of face and Navon condition, $F(1, 37) = .02$, $p = .892$, $\eta_p^2 = .00$ were also not significant.

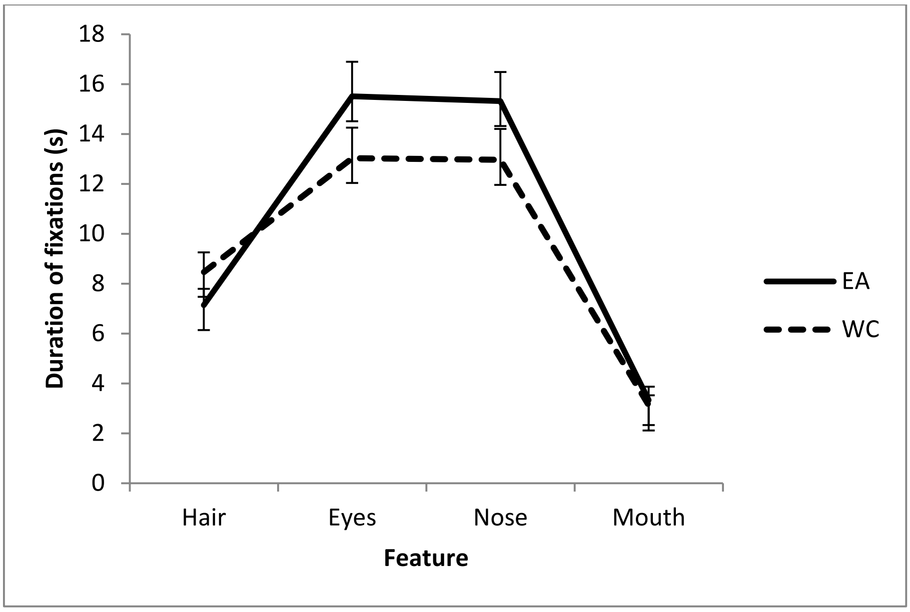


Figure 2.9 Interaction between Race of Face and Feature for duration of fixations landing on the hair, eyes, nose and mouth. Error bars report standard errors of mean.

2.3.3 Verbal descriptions

A 2 (race of face: East Asian [EA] or White Caucasian [WC]) x 4 (feature: hair, eye, nose or mouth) x 2 (description type: featural or configural descriptions) repeated-measures ANOVA was conducted on the summed description frequencies for the hair (estimated marginal mean$\pm$s.e = 1.18+0.13), eyes (1.13$\pm$0.126), nose (0.46$\pm$0.06) and mouth (0.48$\pm$0.06). However, as some of the variables were not normally distributed (Shapiro-Wilk $p < .05$), the equivalent nonparametric tests were also conducted and reported in Appendix A. ANOVAs were conducted as ANOVAs are fairly robust to violations of normality.

2.3.3.1 Feature

A main effect of feature, $F(2.45, 100.46) = 27.23$, $p < .001$, $\eta_p^2 = .40$ was found. Bonferroni-corrected pairwise comparisons showed that hair descriptions were significantly more frequent than nose (mean difference = 1.44; $p < .001$) and mouth (mean difference = 1.40; $p < .001$) descriptions; eye descriptions were also significantly more frequent than nose (mean difference = 1.35; $p < .001$) and mouth (mean difference = 1.30; $p < .001$) descriptions. No significant differences between hair and eye (mean difference = 0.093; $p = 1.000$), and nose and mouth (mean difference = .05; $p = 1.000$) description frequencies were found. In summary, participants described the hair and eyes significantly more frequently than the nose and mouth. See Figure 2.10.

The interaction effect for race of face and feature was nonsignificant, $F(3, 123) = 0.042$, $p = .99$, $\eta_p^2 = .001$, thus suggesting that description frequencies for the East Asian and White Caucasian faces did not differ on any of the features. This suggests that Malaysian Chinese participants describe East Asian and White Caucasian faces in a similar pattern, i.e. hair and eyes, followed by the nose and mouth.

No significant main effect was found for Navon condition, $F(1, 41) = 1.84$, $p = .182$, $\eta_p^2 = .04$. The interactions of feature and Navon condition, $F(3, 123) = .05$, $p = .985$, $\eta_p^2 = .00$ and race of face, feature and Navon condition, $F(3, 123) = .02$, $p = .996$, $\eta_p^2 = .00$, were not significant. Thus, we did not see an impact of Navon condition on description strategy.

The main effect of race of face, $F(1, 41) = .74$, $p = .394$, $\eta_p^2 = .02$ and the interaction of race of face and Navon condition, $F(1, 41) = .34$, $p = .562$, $\eta_p^2 = .01$ were also not significant.

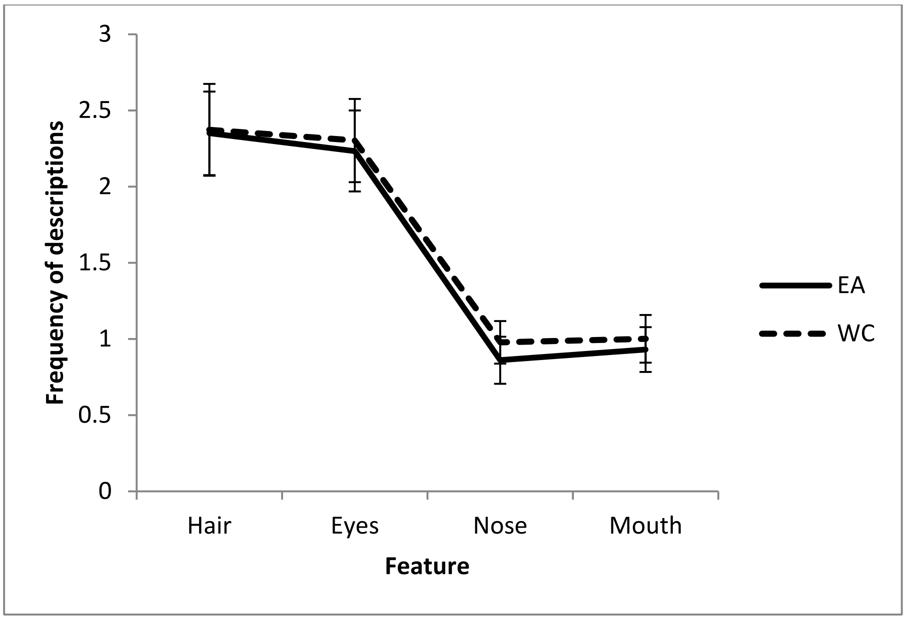


Figure 2.10 Interaction between means of description frequency on the hair, eyes, nose and mouth regions. Error bars report standard errors of the mean.

2.3.3.2 Description type

A 2 (race of face: East Asian [EA] and White Caucasian [WC]) x 2 (description type: featural and configural) x 2 (Navon condition: local or global) mixed ANOVA was performed. Configural description variables were not normally distributed due to floor effects. However, ANOVA was used because it is relatively robust to violations of normality. A significant main effect of description type, $F(1, 41) = 99.26$, $p < .001$, $\eta_p^2 = .71$ was found, indicating that participants provided significantly more featural descriptions than configural descriptions (mean difference = 1.42, $p < .001$).

No significant main effect of race of face, $F(1, 41) = .74$, $p = .394$, $\eta_p^2 = .02$, or interaction effect between description type and race of face was found, $F(1, 41) = 2.81$, $p = .10$, $\eta_p^2 = .06$.

The main effect of Navon condition, $F(1, 41) = 1.84$, $p = .18$, $\eta_p^2 = .04$, interaction between condition and description type, $F(1, 41) = 2.76$, $p = .104$, $\eta_p^2 = .06$, interaction between Navon condition and race of face, $F(1, 41) = .34$, $p = .562$, η_p^2

= .01, and interaction between Navon condition, race of face and description type, $F(1, 41) = .46$, $p = .502$, $\eta_p^2 = .01$ were not significant indicating that Navon condition did not impact on the use of configural or featural descriptions to describe faces.

2.4. Discussion

2.4.1 Processing orientation and recognition accuracy

Participants recognised both the Asian and Caucasian pool player above chance levels. They did not recognise the own-race Asian face more reliably than the other-race Caucasian face, in line with recent literature suggesting that exposure to other-race faces improves their recognition (Kelly et al., 2011), and that Malaysian Chinese participants are equally good at recognising Caucasian as Asian faces (Tan et al., 2012).

We found no effect of the Navon task on recognition accuracy. The hypothesis that participants in the global condition will perform significantly better on recognition accuracy than participants in the local condition is therefore not supported. It has been suggested that local and global processing do not form a continuum, but rather represent two discrete cognitive mechanisms (Fink et al., 1997). Malaysian Chinese participants have been found to use a looking strategy that is intermediate between Western-style local processing and Eastern-style global processing (Tan et al., 2012), using both global and local processing mechanisms. This existing activation of both cognitive mechanisms may explain the lack of difference in looking strategy between participants in local and global Navon task conditions, whereas in previous studies with Caucasian participants, the activation of global processing mechanisms has enhanced recognition accuracy in a similar task (Macrae & Lewis, 2002).

Lewis, Mills, Hills and Weston (2009) suggest that verbal overshadowing (the phenomenon whereby participants' recognition of faces is impaired by including a face description task between the learning and recognition phases of a face recognition task) may be attributable to a Transfer Inappropriate Processing Shift (TIPS). This hypothesis suggests that face recognition is enhanced when encoding and recognition occur in the same processing style (i.e. both global or both local). In the current study, the Navon task was performed between the encoding and recognition phases, meaning that we cannot be certain whether or not the Navon task induced a TIPS. It should be noted, however, that the original paper by Macrae and Lewis (2002) also included the Navon task between the encoding and recognition phases. It is possible also, that the verbalisation of facial features that took place in the current study between the learning and recognition phases could have induced a shift to local processing, a phenomenon known as verbal overshadowing (Dodson, Johnson and Schooler, 1997; Schooler & Engstler-Schooler, 1990). This may then have reduced or eliminated the effect of the Navon task on processing orientation.

It should also be noted that there have been a number of previous failures to replicate the effect of a Navon task on face recognition. For example, Lawson (2007) reports three failed replications, and Brand (2004) reports one failed (n = 153) and one successful (n = 198) replication using large sample sizes, suggesting that the effect may not be as robust as reported in Macrae and Lewis (2002). However, this also suggests that our failure to replicate the result may be attributable to our relatively small sample size being unable to detect such a small effect.

2.4.2 Looking strategy

Our results showed that Malaysian Chinese participants maintained their unique intermediate looking strategy when looking at East Asian and White Caucasian faces, fixating mainly on the eyes and nose and less on the mouth (Tan et al., 2012). In the current study, an additional area of interest, Hair, was added in order to make parallel comparisons with the verbal descriptions. The most and longest fixations fell on the eyes and nose, followed by the hair, and then the mouth. It was found that while eye movements were similar for the eyes, nose and mouth when viewing both the East Asian and White Caucasian faces, participants fixated more and for longer on the hair for the White Caucasian face. This lends support to Ellis et al.'s (1975) finding that hair provides useful cues for discrimination in White Caucasian faces. Therefore, our hypothesis that participants adapt their looking strategy to suit the race of face that they are looking at is partially accepted.

2.4.3 Verbal description of faces

Our results revealed significant differences in verbal descriptions between features, with hair and nose descriptions being described significantly more frequently than the nose and mouth. No significant differences were found between descriptions for the East Asian and White Caucasian faces across all features. This indicates that Malaysian Chinese use different strategies to look at and to describe faces, but maintain the same strategy when describing East Asian and White Caucasian faces, suggesting that looking and description strategies may be determined by different factors.

In both tasks, the eyes received the most attention, with significantly longer fixations and more frequent descriptions. However, a significant contrast was found in the way in which participants fixated and described the nose. The mouth region received the least attention for both tasks, suggesting that the mouth is a less useful cue for face discrimination for Malaysian Chinese.

Malaysian Chinese participants used significantly more featural descriptions than configural descriptions for both East Asian and White Caucasian faces, contrary to the hypothesis that Malaysian Chinese use more configural descriptions when describing the East Asian face and more featural descriptions when describing the White Caucasian face. In Ellis et al. (1975), participants described faces based on which features gave more useful cues to discrimination for their own race. In this study, however, participants' descriptions showed a significant local component for both races. It is possible that Malaysian Chinese participants used a Western style of describing faces because English was spoken throughout, a phenomenon that is in line with the Sapir-Whorf Hypothesis that people think differently when speaking in a different language (Luna, Ringberg, & Peracchio, 2008; Ting & Dueck, 2006).

2.4.4 Conclusion

In conclusion, our main findings are that 1) Malaysian Chinese maintain their unique looking strategy of looking more at the eyes and nose, but looked at White Caucasian hair more frequently and for longer; 2) the Navon task did not have an effect on recognition accuracy or on changing looking strategy; 3) Malaysian Chinese verbally described the hair and nose more frequently than the nose and mouth; and 4) Malaysian Chinese used different strategies for both the looking and description tasks. While Malaysian Chinese use an intermediate strategy that may be appropriate for recognising faces in the multi-cultural society in which they live (Tan et al., 2012), they rely on more local descriptions, possibly influenced by Western culture to which they have constant exposure, the language in which they described the face, or that local descriptions are easier to describe than global descriptions.

Chapter 3
Do language and culture affect face processing strategies?

3.1 Introduction

3.1.1 Perceptual differences between East Asians and White Caucasians

Individuals from collectivist societies have been shown to display relatively higher interdependence than individuals from individualist societies (Brewer & Chen, 2007), due to the importance of maintaining harmony within the group (Kanagawa, Cross, & Markus, 2001). East Asian cultures, including Malaysia, fall into the collectivist range on measures of individualism-collectivism (Hofstede, Hofstede, & Minkov, 2010), and this is thought to coincide with a more holistic processing style across a number of cognitive tasks (Ji, Peng, & Nisbett, 2000; Kitayama et al., 2003). This more holistic cognitive style may make East Asians more sensitive to contextual information and contextual cues in the environment (Kim, Pan, & Park, 1998).

Self-descriptions were found to be more dependent on context in Japanese participants than American participants (Kanagawa et al., 2001). Participants were asked to describe themselves in four situations: in a group, alone in a research booth, with a peer, or with the experimenter. Kanagawa et al. (2010) found that when they were not alone, Japanese participants were more self-critical and provided more negative descriptions of themselves, in line with the cultural ideal that values modesty and harmony, and conformation to the in-group or social situation they are in. On the other hand, the American participants' self-descriptions were significantly less dependent on social contexts.

Similar cultural differences, i.e. preference for featural or configural processing styles, have also been found in the performance of cognitive tasks. In a change blindness study by Bodoroglu, Shah, and Nisbett (2009), East Asian participants were faster at identifying colour changes when the background layout was expanded, but slower than Americans at identifying changes which occurred in the middle of the screen. Bodoroglu et al. (2009) suggested that East Asians allocate their visual attention more broadly than do Westerners.

Further, recent eye-tracking studies on how East Asians and White Caucasians perceive scenes also reflect similar cultural differences. Chua, Boland, and Nisbett (2005) presented a series of pictures with single foregrounded objects on realistic backgrounds. American participants fixated more on the focal object than the Mainland Chinese participants who fixated more on the background.

These studies illustrate some of the differences in characteristics of people from individualist and collectivist cultures, and suggest that contextual cues are important to people from collectivist cultures relative to those from individualist cultures. These differences have also been reflected in the ways with which East Asians and White Caucasians perceive faces (discussed in the following section), which leads to the explanation that an individual’s cultural background influences the way he/she perceives faces.

3.1.2 Looking strategy in face perception

Configural processing has been found to be more advantageous in recognising own- than other race faces (McKone, Davies, Fernando, Aalders, Leung, Wickramariyaratne, & Platow, 2007), and same-race faces are processed more configurally than other-race faces (Michel, Rossion, Han, Chung, & Caldara, 2006), suggesting that processing style becomes more configural as familiarity with an ethnic group of faces increases.

Recent eye-tracking studies have demonstrated that individuals of different cultural backgrounds use different looking strategies to extract information from faces (Blais et al., 2008; Jack et al., 2009), as well as non-face objects (Kelly et al., 2010). East Asians have been found to fixate more on the centre region of the face (the nose region), while White Caucasians fixate more on the eyes and mouth regions, across different tasks, suggesting preferences for configural and featural processing, respectively (Blais et al., 2008).

Individuals with extended exposure to faces of different ethnicities have been found to adopt an intermediate strategy to look at faces, combining typically Western featural and typically Eastern configural strategies by looking more at the eyes and nose regions. Kelly et al. (2011) suggested that British-born Chinese participants showed preferences for either featural or configural strategies typical to East Asians or White Caucasians. However, Tan et al.'s (2012) reanalysis of the data suggested that they use an intermediate strategy of looking at the eyes and nose, instead of adopting either a strictly Asian or strictly Western looking strategy. Malaysian Chinese participants, who come from a multicultural society and with significant Western influence from the mass media and former British colonisation (Epstein, 2011), have also been found by Tan et al. (2012) to use an intermediate strategy, looking more at the eyes and nose regions. However, it is not known whether these variations in looking strategy are a result of general cognitive differences between cultures outlined above, or a result of individuals adapting their looking strategy to best identify diagnostic features of faces that are most advantageous to recognising faces in their environment.

3.1.3 Verbal description of own- and other-race faces

While cultural background may influence how people look at faces, there is also evidence which suggests that people of different ethnicities describe faces differently, suggesting that certain features that are more useful for discriminating between individuals of a particular race are mentioned more frequently when describing own- and other-race faces (Ellis, Deregowski, & Shepherd, 1975). Ellis et al. (1975) found that when White Caucasian and Black African participants described a series of photographs of own- and other-race faces, White Caucasians provided more featural descriptions (e.g. iris colour, hair colour and hair texture) while Black African participants provided more configural descriptions (e.g. position of hair and hair outline). They suggested that these differences could have arisen from the variation of facial appearance in these two ethnic groups; for example, White Caucasians have more variations in hair and iris colour, while Black Africans have predominantly black hair and dark eyes.

Contrary to Ellis et al. (1975), our results in Chapter 2 suggest that Malaysian Chinese participants provided significantly more local descriptions than global descriptions. Another finding was that Malaysian Chinese participants used two distinct patterns for fixating on and describing faces. The eyes and nose regions were fixated on the most frequently, but the hair and eye regions were described significantly more frequently. Thus we suggested that the features described might reflect what is easier to describe rather than what is useful for identification, but that visual information is not bound by linguistic constraints.

Based on anecdotal observation, participants with stronger Chinese accents provided more global descriptions than those with more Standard English accents; individuals with increased cultural exposure to Chinese culture may be more collectivistic in thinking, and thus may be more likely to provide more global than local descriptions. We also suggested that speaking in English may have led to a shift in participants' cognitive processing, a phenomenon in line with the Sapir-Whorf Hypothesis that people behave or respond differently when speaking in different languages.

3.1.4 The use of language as a cultural prime

Whether language influences thought has been the subject of much debate. According to the Sapir-Whorf Hypothesis (Whorf, 1956), the language one speaks influences how he/she thinks. Bicultural individuals are known to frame-switch between cultural mindsets with which they are familiar (Luna, Ringberg, & Peracchio, 2008). Lee, Oyserman and Bond (2010) defined cultural mindsets as "a mental interpretation or cognitive schema containing culture-congruent content, procedures, and goals" (p. 785), for example, an individualist or collectivist cultural mindset. Different cultural mindsets have been shown to be evoked when bilingual and/or bicultural participants speak in the language with which the concepts are associated (Pavlenko, 2003; Ross, Xun, & Wilson, 2002). For example, English is thought to evoke an individualist mindset, as English-speaking people have been shown to be more individualistic than people from other societies (including other Western Europeans who speak different languages; Oyserman, Coon, & Kemmelmeier, 2002); on the other hand, Chinese culture represents a collectivist mindset (Lee et al., 2010).

Priming bilingual participants in two different languages, when performing identical or similar tasks, has been shown to elicit differences in responses, such as verbal recall of academic information in Spanish and English (Marian & Fausey, 2006) and autobiographical memory in Russian and English (Marian & Neisser, 2000).

Marian and Neisser (2000) prompted Russian-English bilinguals, who had immigrated to the United States at the mean age of 14.2, using 16 pairs of cue words (e.g. *birthday, frightened, holiday* and *laughing*; with the equivalent Russian translations). They found that when participants were cued in Russian, they mentioned more memories from the Russian-speaking part of their lives; conversely, more memories from the English-speaking part of their lives were mentioned when cued in English.

A similar phenomenon was observed when Chinese-English bilinguals were asked ambiguous questions with two or more possible answers (e.g. "Name a statue of someone standing with a raised arm while looking into the distance"). Participants were more likely to name the Statue of Mao when asked in Chinese and the Statue of Liberty when asked in English, thus suggesting a connection between cultural and linguistic contexts (Marian & Kaushanskaya, 2007). Priming participants using culturally-significant icons of Chinese culture and American culture (e.g. the Great Wall vs. the Capitol building) also led to bicultural frame-switching among Hong Kong Chinese participants, whereby they exhibited more confidence in external attributions, a characteristic of collectivistic culture, when speaking Chinese (Hong, Morris, Chiu, & Benet-Martínez, 2000).

Chinese-born Canadians who were assigned to respond in Chinese provided more collectivistic self-statements in open-ended self-descriptions, lower self-esteem on the Rosenberg scale, and more agreement with Chinese cultural views than the control participants or Chinese-born Canadians assigned to respond in English (Ross et al., 2002). In a clinical setting, Chinese-English bilinguals in Hong Kong used more interpersonal language when describing depressive symptoms in Chinese than in English (Ting & Dueck, 2006).

Further, Pavlenko (2003) also found cross-linguistic differences when Russian-English bilinguals were recalling scenes from videos shot in Kiev, Ukraine, and Ithaca, New York, in which a man comes to sit down within close proximity to a woman on a bench. Participants were prompted either in Russian or English, and described either the video shot in Kiev or the video shot in Ithaca. Participants were found to mention concepts such as “privacy” and “personal space” that are present in English but not in Russian more frequently when speaking English than when speaking Russian.

These findings demonstrate that language can be used to prime certain cultural mindsets in people, which in turn suggests that individuals adapt their thoughts and behaviour as they shift from one language or culture to another. However, it is not known whether priming participants in languages that come from individualist (English and German) and collectivist cultures (Chinese) can lead to a cultural shift, whereby fixation patterns and verbal descriptions can be altered during face perception tasks.

Thus, in the current study, we prime Malaysian Chinese and Austrian Caucasian participants in Mandarin and German, respectively, and compare the resulting looking and description patterns. If the cultural hypothesis is correct, we would predict language priming to impact on the Malaysian Chinese participants’ description and looking strategy, but not the Austrian Caucasians’. Conversely, if the facial information hypothesis is correct, we would predict that participants look at and describe facial features that are most diagnostic for identification for each face ethnicity.

If cross-cultural cognitive differences drive the differences in looking and description styles, we predict that priming bilingual participants with cultural cues related to Chinese (collectivist) or English (individualist) cultures will cause differences in face processing style, leading to more configural looking strategy (focus on the nose) in the Chinese cultural prime condition and a more featural looking strategy (focus on the eyes and mouth) in the English cultural prime condition. However, in the comparison group of Austrian Caucasians, we would predict no, or a much reduced, shift in cognitive styles, since both English and German are languages from individualistic cultures.

In this study we use a novel cultural-priming method to prime bilingual Malaysian Chinese/English participants to describe East Asian and White Caucasian faces in English and Chinese, as well as a comparison group of bilingual Austrian German/English participants who will describe the same faces in English and German. We will examine our findings in relation to the facial information hypothesis and the cultural explanation. If the facial information hypothesis is supported, fixation patterns and verbal descriptions should follow similar patterns based on what is useful for identifying faces. On the other hand, if the cultural explanation is supported, language priming should influence fixation and verbal description patterns, whereby participants use more featural processing when speaking in English and vice versa.

We will describe in Study 1 the Methods and Results from the Malaysian Chinese data, and the same for the Austrian data in Study 2.

3.1.5 Hypotheses

1) If cultural primes cause shifts in cognitive style, we would expect to see participants exhibit a more configural looking strategy (focusing more on the nose) and more configural descriptions when speaking Chinese, and a more featural looking strategy (focusing on eyes and mouth) and descriptions when speaking English or German.

2) If looking and description strategy is determined by the diagnostic features of the faces, we would expect to see looking strategy and description style differ based on the race of the faces, with more configural strategies used for Asian faces and more featural strategies used for Caucasian faces.
3) If descriptions are bound by language, we would expect to see more configural descriptions but not looking strategy for Chinese language conditions, and more featural descriptions but not looking strategy for English and German language conditions.

3.2 Methods

Two sets of bilingual participants: Malaysian Chinese bilingual in Mandarin and English, and Austrian Caucasians bilingual in English and German were asked to describe a series of East Asian and Caucasian faces, and the audio of their descriptions was recorded. Their eye movements were also recorded. Participants completed the task (with different faces) twice – once in English following an English cultural prime, and once in Mandarin, following a Chinese cultural prime (Malaysian Chinese participants) or German, following a German cultural prime (Austrian Caucasian participants).

3.2.1 Design

A 2 (language: English or Other Language) x 2 (race of face: East Asian [EA] or White Caucasian [WC]) x 4 (feature: hair, eyes, nose, mouth) x 2 (nationality: Malaysian or Austrian) mixed design was used. The dependent variables were the total number of fixations and total duration of fixations for the eye-tracking data, and description frequency for verbal descriptions.

3.2.2 Participants

Malaysian Chinese Sample

Participants consisted of 37 Malaysian Chinese (48.5% male, *M* = 21.29 years, *SD* = 2.11) who were fluent in English and Mandarin and were recruited from the University of Nottingham Malaysia Campus. All participants had normal or corrected-to-normal vision, and received course credit or RM10 for participation. All protocol was approved by the University of Nottingham Malaysia Campus ethics committee.

Austrian Caucasian Sample

Thirty-two Austrian Caucasian participants (48.1% male, M = 22.52, SD = 3.22) who were fluent in both English and German were recruited from the University of Vienna. Six participants were excluded as they reported being from non-German speaking countries. All participants had normal or corrected-to-normal vision, and received course credit. All protocol was approved by the University of Nottingham Malaysia Campus and the University of Vienna ethics committee.

3.2.3 Language history

Upon completion of the language priming tasks, participants were given a language history questionnaire (Li et al., 2006) to complete, in which they provided details of their proficiency (on a 7-point Likert scale) in reading, speaking, writing and understanding English, Mandarin/German, and other languages they know; years spent learning these languages; and the estimated number of hours per day for which they speak each language.

For the Malaysian Chinese Sample, the mean rating for English spoken proficiency was 5.24 (SD = .90) and the mean rating for Chinese spoken proficiency was 5.60 (SD = 1.25). Nine participants (25.7%) reported speaking English as their first language and 24 participants (68.6%) reported speaking Mandarin as their first language. Participants also reported speaking English on average 8.30 hours each day

(SD = 5.60) and Chinese an average of 5.73 hours each day (SD = 4.64). Two participants (5.7%) provided missing values.

For the Austrian Caucasian Sample, the mean rating for English spoken proficiency was 4.87 (SD = 1.48) and the mean rating for German spoken proficiency was 7.00 (SD = 0.00). 26 participants (96.3%) reported speaking German as their first language and one participant (3.7%) reported speaking English as their first language. Participants also reported speaking German on average 12.44 hours each day (SD = 7.30) and English an average of 4.16 hours (SD = 7.30) each day

3.2.4 Materials

Stimuli for the cultural priming consisted of the information sheet, consent form and music video in the target language. The photographic stimuli were used in the verbal description task.

3.2.4.1 Information sheet and consent forms

The information sheet and consent form was forward-translated from English to Chinese (Simplified; Malaysian sample) or German (Austria; Austrian sample) by the experimenter, who is fluent in both languages, and then back-translated by Research Assistant who was fluent in both the relevant languages, and who was blind to the experimental hypotheses, to ensure consistencies across language versions. Where there were inconsistencies between the original English version and the back-translated version, either the original English version or the other version was revised.

3.2.4.2 Music videos

Three music videos were downloaded from YouTube: What Makes You Beautiful (performed by One Direction in English) and 我的歌聲裡 [You Exist in My Song] (performed by 曲婉婷 [Wanting Qu] in Mandarin) and Applaus! Applaus! (performed by Sportfreunde Stiller in German). The videos were current pop songs on

Billboard and local radio charts at the time of the experiment (April 2013 for the Malaysian sample, December 2013 for the Austrian sample), so that most participants would be familiar with the songs and music videos. All videos were downloaded from the artists' official YouTube pages with frame heights of 720 pixels. The English-language video depicts the five members of the band (all male; 4 White Caucasian, 1 British Pakistani) on a beach, meeting and singing to two White Caucasian women. The Chinese-language video depicts the female singer reminiscing about the times with an ex-boyfriend; all the persons in this video are East Asian. The German-language video depicts the four members of the band playing the song in a clearing in the woods; all the persons in this video are male and White Caucasian. These videos were chosen as being identifiably Anglosphere, Chinese or Germanic respectively, featuring well-known artists and easily understandable lyrics in their respective language.

3.2.4.3 Photographic stimuli

The photo stimuli for both samples consisted of 16 faces (8 East Asian, 8 White Caucasian, 50% male), photographed in a lighting booth painted with Munsell N5 neutral grey paint and illuminated with d65 fluorescent tubes, in high frequency fixtures to reduce the effects of flicker (Verivide, UK). All images were calibrated after Stephen, Law Smith, and Perrett (2009). The background was edited using GIMP 2 photo manipulation software to remove the colour card and to ensure a standard shade of grey. The images were aligned on the eyes' position using PsychoMorph software (Tiddeman & Perrett, 2001) and were 486 x 597 pixels in size.

3.2.4.4 Eye tracking

Malaysian Chinese Sample. A Tobii T60 on-screen remote eye-tracking system was used to record the eye movement data through an infra-red camera integrated to the lower-part of the 17in TFT monitor. The eye-tracker has a high accuracy (to 0.5°) and drift compensation (less than 0.3°) and performs binocular tracking at a data sampling rate of 60 Hz. This non-intrusive eye-tracker allows for large freedom of head movement, thus allowing participants to behave naturally without any visible or moving tracking device which may affect them.

A calibration procedure, implemented in the Tobii Studio 3.0 software, preceded both language blocks to ensure accurate tracking of eye-gaze. Once participants' eyes were detected by the infra-red camera, shown as two moving dots on the interface dialogue box, a standard nine-point calibration procedure began to determine the direction of participants' eye gaze.

Austrian Caucasian Sample. Binocular recordings were obtained with an EyeLink SR 1000 eye-tracker (SR Research Ltd., Mississauga, Ontario, Canada) at a sampling rate of 500Hz. A chin- and forehead-rest was used to stabilise participants' head movements and maintain viewing distance at 72cm from the screen. An angular 25mm lens was mounted diagonally for binocular tracking. The host application runs on a ROM DOS environment, which allows the experimenter to view real-time gaze position overlaid on a static display representation while data is being recorded. It allows for preference selection, camera setup, calibration and recording functions.

Stimuli were presented on a 19-inch colour CRT display monitor with a resolution of 1024x768 pixels and a vertical refresh rate of 100Hz. First, the focus was adjusted until both of the participants' eyes appeared sharp on the experimenter's control monitor. A five-point calibration was then implemented for binocular-tracking. A drift check in the middle of the screen was implemented before the start of every trial. Recalibrations were performed if recorded fixation gaze average was outside a 1° radius of the pretrial drift check target circle.

3.2.5 Procedure

The experiment consisted of two language blocks. The order of presentation of language blocks was counterbalanced between participants. Within each language block, all participants completed the following procedures:

3.2.5.1 Language priming

Participants were given an information sheet (in Chinese/German or English) to read, understand and indicate their consent to participate. After completing the consent form, participants watched a music video of a pop song in the same language as the instructions. The experimenter spoke to the participant in only the language of the current block throughout. The order in which the language primes (Chinese/German or English) were given was counterbalanced.

3.2.5.2 Facial eye-tracking and description

Eight faces (4 East Asian, 4 White Caucasian, 50% male) were presented on the screen for 60s each. The image stimuli extended a visual angle of 12.39° (horizontal) and 14.85° (vertical). The faces of each ethnicity were presented in two separate blocks, with the order of East Asian and White Caucasian faces counterbalanced; within each block, the order in which the four faces are presented was randomised. Participants were asked to describe each face, in the same language as the current language block, in as much detail as possible, and to use the full minute to make descriptions.

These two tasks were then repeated in the other language (e.g. English block followed by Chinese/German block, or vice versa). A different set of eight faces was used in the second half of the experiment, to avoid participants describing the same faces more than once. See Figure 3.1.

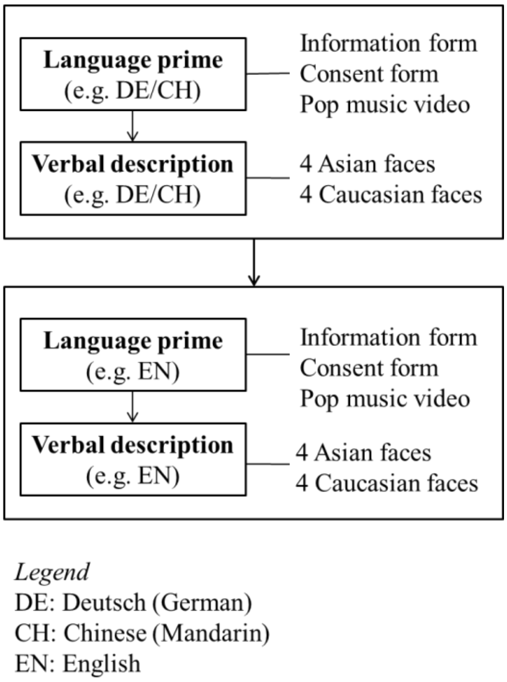


Figure 3.1 Flow chart depicting the experimental procedure for English and Chinese or German-language priming

3.3 Results

3.3.1 Data analysis

3.3.1.1 Eye-tracking

Malaysian Chinese Sample. Initial data extraction occurred within the Tobii Studio v3.0 software. Areas of interest (AOIs) were defined for each image by delineating the hair, eyes, nose and mouth regions following Tan et al. (2012) (Figure 2). The Velocity-Threshold (I-VT) fixation filter from Tobii Studio detects the eyes' angular velocity (30°/second) and discards fixations that are less than 60ms (Olsen, 2012). Samples that are of the same or higher velocity of this threshold are classified as belonging to a saccade (Olsen, 2012).

The total number and total duration of fixations that fell within the predefined areas of interest (Hair, Eyes, Nose and Mouth) was calculated. Fixations falling on the left and right eyes (depicted as L and R in Figure 2) were combined to a single “Eyes” AOI. To ensure the validity of the eye-tracking data, a sampling percentage of 50% on Tobii Studio was used as a minimum for inclusion for data analysis. See Figure 3.2.

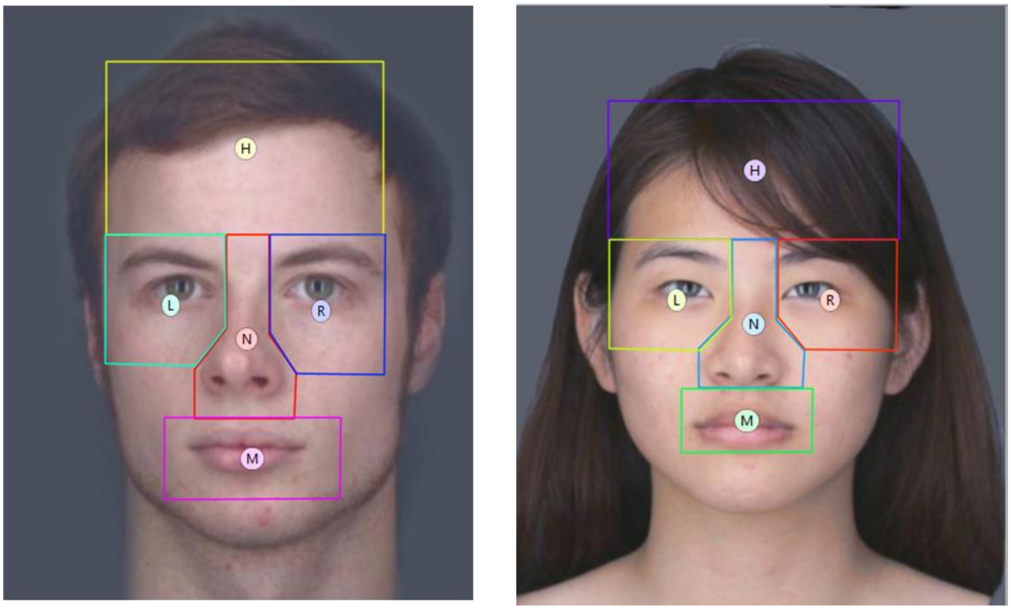


Figure 3.2 Areas of Interest: Hair, Eyes (left and right), Nose and Mouth

Austrian Caucasian Sample. Areas of Interest (AOIs) were defined for each image on Adobe Illustrator by delineating the hair, eyes, nose and mouth regions following Tan et al. (2012) (these were the same as in the Malaysian sample). Each predefined AOI was assigned a different RGB grey value, so that the number of fixations corresponding to each of these values is recalled on Matlab. The data was then extracted from Matlab.

Following the SR Research algorithm, fixations were defined as the average gaze position during periods when the change in recorded gaze position was smaller than 0.1°, eye movement velocity below 30°/s, and acceleration below $8000°/s^2$, respectively. Fixations below 100ms and above 2000ms were excluded from the analysis.

The total number and total duration of fixations falling on each of the predefined AOIs was calculated. Fixations falling on the left and right eyes (depicted as L and R in Figure 3.2) were combined to a single “eyes” AOI.

3.3.1.2 AOI normalisation

As the AOIs could be of different sizes, it is possible that the fixation count or fixation duration data reflect the relative areas of the AOIs, rather than the absolute interest that a particular AOI holds for an observer. The fixation count and fixation duration scores were therefore area-normalised to address this issue. This was achieved by dividing the percentage of fixations to an AOI by the size of the AOI, which was expressed as the percentage of the total area of a face (Bindemann, Scheepers, & Burton, 2009), as summarised by the following formula:

$$\frac{\text{Number of fixations on AOI / Number of fixations on all AOIs}}{\text{Area of AOI / Total area of all AOIs}}$$

Based on the area-normalised scores, the means of proportions of all the faces were then calculated. This also had the effect of ensuring that the Malaysian and Austrian data were on the same scale and were therefore directly comparable.

3.3.1.3 Verbal descriptions

Coding rules

The face was divided into four regions according to the AOIs depicted in Figure 2, i.e. the Hair, Eyes, Nose and Mouth regions. The description component was further divided into featural and configural description types. Featural descriptions were operationally defined as ‘descriptions about a particular feature of the face’, and configural descriptions were operationally defined as ‘descriptions on the relationship between two or more features, the position of a particular feature in relation to the face. or general impressions of a feature’. See Table 3.1.

Table 3.1
Guidelines for coding verbal descriptions.

Feature	Description type	
	Featural	Configural
Hair and forehead	Hair: hairstyle, colour, length Forehead: width	Comparison to other features Relationship between features*
Eye region	Eyes: colour, size, shape, tired Eyebrows: thickness, colour Spectacles/no spectacles	Eyes: distance apart, symmetry Looks: nice eyes Relationship between features*
Nose region	Size, nostril size, width	Position**, symmetry
Mouth region	Lips: colour, size, shape Moustache/no moustache	Smiling, frowning

Note:

* Two or more features mentioned within the same description (e.g. "fringes extend over eyes", "eye brows extend over eyes", etc.
** Position in relation to the face (e.g. "in the middle of the face").

Intercoder reliability

Three independent raters who were fluent in Mandarin and English, and blind to the hypotheses, were recruited to code the verbal descriptions. The raters were asked to replay the recordings directly in Tobii Studio, and code the participants' descriptions from the description task into categories as depicted in Table 1. Data from the three raters were calculated to obtain a Cronbach's α for each rating category. The mean Cronbach's α for Local and Global descriptions was 0.90 and 0.67 respectively, indicating acceptable intercoder reliability.

The three raters' mean ratings for each rating category (e.g. English/East Asian faces/Eye/Local) were calculated and used in the analysis.

Two independent raters who were fluent in German and English, and blind to the hypotheses, were recruited to code the verbal descriptions, and were given the same instructions as the Malaysian raters. The mean Cronbach α for Local and Global description was 0.72 and 0.55 respectively, indicating medium to high inter-coder reliability.

The mean of the two raters' ratings were calculated for each rating category (e.g. English/East Asian faces/Eye/Local) and used in the analysis.

3.3.1.2 Correlations between language fluency (CV) and dependent variables (DV)

Correlations between verbal description frequencies and language fluency ratings were conducted to ascertain whether there is a direct correlation between language fluency and verbal description frequencies. If fluency were to be driving the results, a correlation between language and description frequency would be found.

Thirty-two bivariate correlations were also conducted between English or Chinese fluency and description frequency for the Malaysian Chinese sample. All correlations were nonsignificant after Bonferroni correction, $p > 0.002$ (0.05/32). Thirty-two bivariate correlations were also conducted between English or German fluency and description frequency for the Austrian Caucasian sample. All correlations were nonsignificant after Bonferroni correction, $p > 0.002$ (0.05/32).

Altogether, the correlation results indicate that fluency in one language had no effect on description frequencies when the participant was speaking in the other target language. Further, the correlations do not extend to looking strategies at non-focal AOIs. Thus the language fluency variables were not included in further analyses. See Appendix D for correlation tables.

3.3.2 Eye-tracking

Two participants were excluded from analysis, as their sampling rate on Tobii Studio fell below 50%.

3.3.2.1 Fixation count

The Malaysian Chinese and Austrian Caucasian data was combined. A 2 (language: English or Other Language [Chinese for the Malaysian data or German for the Austrian data]) x 2 (race of face: East Asian [EA] or Western Caucasian [WC]) x 4 (feature: hair, eyes, nose or mouth) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged proportion of fixation count falling on the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

There was a main effect for feature, $F(2.30, 140.62) = 326.99$, $p < 0.001$, $\eta_p^2 = 0.84$), whereby there were more fixations on the nose than hair (mean difference = 2.84, $p < 0.001$) , eyes (mean difference = 1.24, $p < 0.001$), and mouth (mean difference = 1.51, $p < 0.001$); more fixations on the eyes than hair (mean difference = 1.60, $p < 0.001$), and mouth (mean difference = 0.27, $p = 0.04$); and more fixations on the mouth than hair (mean difference = 1.33, $p < 0.001$). These results suggest that participants looked most frequently at the nose, followed by the eyes, then the mouth, and least of all the hair. A main effect for race of face was also found, $F(1, 61) = 67.12$, $p < 0.001$, , $\eta_p^2 = 0.52$. East Asian faces (*EMM* = 2.02, *SE* = 0.23) were fixated upon more frequently than White Caucasian faces (*EMM* = 1.82, *SE* = 0.03).

The two-way interaction for race of face and feature was significant, $F(2.42, 147.84) = 20.58$, $p < 0.001$, $\eta_p^2 = 0.25$. Bonferroni-corrected paired-samples t-tests at an adjusted *p* value of 0.0125 (0.05/4) showed that Malaysian and Austrian participants fixated more frequently on Asian mouths than Caucasian mouths, $t(52) = 9.29$, $p < 0.001$, $d = 1.07$. There were significant differences between the proportions of fixation count on Asian eyes and Caucasian eyes, $t(58) = 2.20$, $p = 0.03$, $d = 0.25$; and on Asian nose and Caucasian nose ($t(56) = 2.40$, $p = 0.02$, $d = 0.25$), though these became marginal after Bonferroni correction. There was no difference between the proportion of fixation count on Caucasian hair and Asian hair, $t(49) = 1.90$, $p = 0.06$, $d = 0.20$. See Table 3.2 and Figure 3.3. While the interaction was significant, the results are not in the predicted direction, thus Hypothesis 2 that all participants would show a more configural looking strategy for Asian faces and more featural strategy for Caucasian faces is not supported.

Table 3.2
Means and standard deviations for the race of face and feature interaction

	Feature							
	Hair		Eyes		Nose		Mouth	
Face race	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
East Asian	0.95	0.46	4.30	0.74	6.80	1.31	4.23	1.09
White Caucasian	1.04	0.44	4.13	0.68	6.47	1.37	3.17	0.86

Figure 3.3 Proportions of fixation count for the face race and feature interaction. Error bars represent standard errors of mean.

The three-way interaction for language, feature and nationality interaction was significant, $F(3, 183) = 4.46$, $p = 0.005$, $\eta_p^2 = 0.07$). To further elucidate this interaction, the data was split by nationality. A 2 (language) x 4 (feature) repeated-measures ANOVA was conducted on the split data. When split by nationality, the two-way interaction for language and feature was not significant in the Malaysian data ($F(2.33, 88.46) = 1.35$, $p = 0.264$, $\eta_p^2 = 0.03$) but was significant in the Austrian data ($F(2.22, 51.10) = 3.57$, $p = 0.031$, $\eta_p^2 = 0.13$).

The main effect for feature was significant in the Malaysian data, $F(2.27, 86.39) = 180.14$, $p < 0.001$, $\eta_p^2 = 0.83$. Bonferroni-corrected pairwise comparisons show that the Malaysian Chinese participants looked more frequently at the nose than hair (mean difference = 5.48, $p < 0.001$), eyes (mean difference = 2.24, $p < 0.001$), mouth (mean difference = 2.76, $p < 0.001$); more frequently at the eyes than hair (mean difference = 3.24, $p < 0.001$); and more frequently at the mouth than hair (mean difference = 2.73, $p < 0.001$). There was no significant difference between the number of fixations on the eyes and mouth (mean difference = 0.51, $p = 0.28$). In summary, the Malaysian Chinese participants looked more frequently at the nose (*EMM* = 6.39, *SE* = 0.24), followed by the eyes (*EMM* = 4.15, *SE* = 0.13) and mouth (*EMM* = 3.64, *SE* = 0.16), followed by the hair (*EMM* = 0.91, *SE* = 0.06).

The main effect for feature was also significant in the Austrian data, $F(2.25, 51.80) = 173.61$, $p < 0.001$, $\eta_p^2 = 0.88$. Bonferroni-corrected pairwise comparisons show that the Austrian Caucasians participants looked more frequently at the nose than hair (mean difference = 5.88, $p < 0.001$), eyes (mean difference = 2.72, $p < 0.001$), mouth (mean difference = 3.28, $p < 0.001$); more frequently at the eyes than hair (mean difference = 3.17, $p < 0.001$); and more frequently at the mouth than hair (mean difference = 2.61, $p < 0.001$). There was no significant difference between the number of fixations on the eyes and mouth (mean difference = 0.56, $p = 0.29$). In summary, the Austrian Caucasian participants looked more frequently at the nose (*EMM* = 6.89, *SE* = 0.25), followed by the eyes (*EMM* = 4.17, *SE* = 0.12) and mouth (*EMM* = 3.62, *SE* = 0.18), followed by the hair (*EMM* = 1.01, *SE* = 0.10). Paired-samples t-tests using

Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) showed no significant differences in the proportion of fixations on the hair ($t(23) = 0.74$, $p = 0.47$, $d = 0.14$), eyes ($t(23) = 1.55$, $p = 0.14$, $d = 0.30$), nose ($t(23) = 0.95$, $p = 0.35$, $d = 0.15$) and mouth ($t(23) = 2.32$, $p = 0.03$, $d = 0.56$) when speaking English or German. See Table 3.3 and Figure 3.4.

Hypothesis 1 is not supported in the Malaysian data, since cultural/linguistic priming did not result in a shift to more configural looking strategies in the Malaysian participants when speaking in Chinese. Hypothesis 1 is partially supported in the Austrian data.

Table 3.3
Means and standard deviations for language and feature interaction in the Austrian data

	Feature							
	Hair		Eyes		Nose		Mouth	
Language	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
English	1.05	0.63	4.27	0.67	6.99	1.55	3.32	1.16
German	0.97	0.47	4.08	0.62	6.79	1.07	3.91	0.97

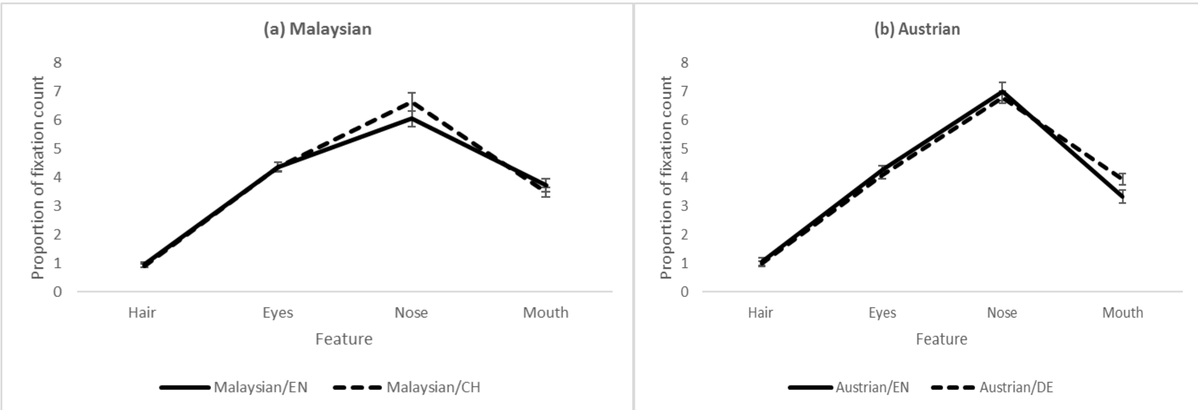


Figure 3.4 Proportions of fixation count for the language and feature interaction: (a) Malaysian data (b) Austrian data. Error bars represent standard errors of mean

Surprisingly, the three-way interaction for language, race of face and feature was significant in the combined data, $F(2.43, 148.37) = 3.96$, $p = 0.015$, $\eta_p^2 = 0.06$.

Separate 2 (race of face) x 4 (feature) repeated-measures ANOVAs were conducted for the English and Chinese/German language conditions. The two-way interaction for race of face and feature was significant in the English-language condition ($F(2.44, 151.40) = 7.25$, $p < 0.001$, $\eta_p^2 = 0.11$) and in the Chinese condition ($F(2.40, 148.80) = 21.72$, $p < 0.001$, $\eta_p^2 = 0.26$). In the English-language condition, Paired-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) show more proportions of fixation count on Asian eyes than Caucasian eyes ($t(62) = 3.31$, $p = 0.002$, $d = 0.41$), and more proportions of fixation count on Asian mouth than Caucasian mouth ($t(63) = 5.15$, $p < 0.001$, $d = 0.63$). No difference between the proportions of fixation count on Asian and Caucasian nose was found ($t(62) = 0.43$, $p = 0.67$, $d = 0.05$); the difference for hair was also non-significant after Bonferroni correction ($t(62) = 2.15$, $p = 0.04$, $d = 0.26$).

In the Chinese/German-language conditions, paired-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) show significantly more proportions of fixation count on Caucasian hair than Asian hair ($t(62) = 3.07$, $p = 0.003$, $d = 0.36$), and more proportions of fixation count on Asian nose ($t(62) = 3.30$, $p = 0.002$, $d = 0.40$) and mouth ($t(62) = 8.15$, $p < 0.001$, $d = 1.18$) than the Caucasians', but no difference between the proportions of fixation count for Asian and Caucasian eyes were found ($t(62) = 0.20$, $p = 0.84$, $d = 0.03$). See Table 3.4.

Table 3.4
Means and standard deviations for the Language, Face Race and Feature interaction

	Feature							
	Hair		Eyes		Nose		Mouth	
Face race	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
East Asian								
English	0.45	0.27	2.20	0.46	3.30	0.92	2.09	0.71
Chinese/German	0.41	0.24	2.07	0.49	3.47	0.83	2.36	0.77
White Caucasian								
English	0.53	0.31	2.00	0.50	3.25	0.93	1.58	0.65
Chinese/German	0.50	0.22	2.05	0.47	3.13	0.87	1.58	0.55

Other interactions were not relevant to our hypotheses and nonsignificant, all p's > 0.05.

3.3.2.2 Fixation duration

The Malaysian Chinese and Austrian Caucasian data was combined. A 2 (language: English or Other Language [Chinese for the Malaysian data or German for the Austrian data]) x 2 (race of face: East Asian [EA] or Western Caucasian [WC]) x 4 (feature: hair, eyes, nose or mouth) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged proportions of fixation duration falling on the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

There was a main effect for feature, $F(2.27, 138.82) = 335.12$, $p < 0.001$, $\eta_p^2 = 0.85$), whereby there were longer fixations on the nose than hair (mean difference = 2.79, $p < 0.001$) , eyes (mean difference = 1.12, $p < 0.001$), and mouth (mean difference = 1.31, $p < 0.001$); longer fixations on the eyes than hair (mean difference = 1.68, $p < 0.001$), and longer fixations on the mouth than hair (mean difference = 1.48, $p < 0.001$). There was no difference between duration of fixations on the eyes and mouth (mean difference = 0.20, $p = 0.25$). These results suggest that participants looked most frequently at the nose (*EMM* = 3.25, *SE* = 0.09), followed by the eyes (*EMM* = 2.13, *SE* = 0.05) and mouth (*EMM* = 1.93, *SE* = 0.06), and least of all the hair (*EMM* = 0.45, *SE* = 0.02).

The two-way interaction for race of face and feature was significant, $F(2.56, 156.09) = 21.33$, $p < 0.001$, $\eta_p^2 = 0.26$, supporting Hypothesis 2. Bonferroni-corrected paired-samples t-tests at an adjusted *p* value of 0.0125 (0.05/4) showed that Malaysian and Austrian participants looked longer at Caucasian hair than Asian hair ($t(62) = 2.71$, $p = 0.009$, $d = 0.37$); longer at Asian eyes than Caucasian eyes ($t(62) = 4.79$, $p < 0.001$, $d = 0.60$); longer at Asian nose than Caucasian nose ($t(62) = 2.92$, $p = 0.005$, $d = 0.32$); and longer at Asian mouth than Caucasian mouth ($t(62) = 10.09$, $p < 0.001$, $d = 1.19$). Hypothesis 2 that looking strategy is based on facial appearance is partially supported, though probably due to the variety of Caucasian hair colour than differences in facial features. Contrary to our predictions, there were longer fixations on Asian eyes in the current data.

Table 3.5
Means and standard deviations for the Face Race and Feature interaction

	Feature							
	Hair		Eyes		Nose		Mouth	
Face race	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
East Asian	0.83	0.38	4.53	0.82	6.66	1.43	4.49	1.20
White Caucasian	0.97	0.37	4.04	0.82	6.18	1.60	3.19	0.97

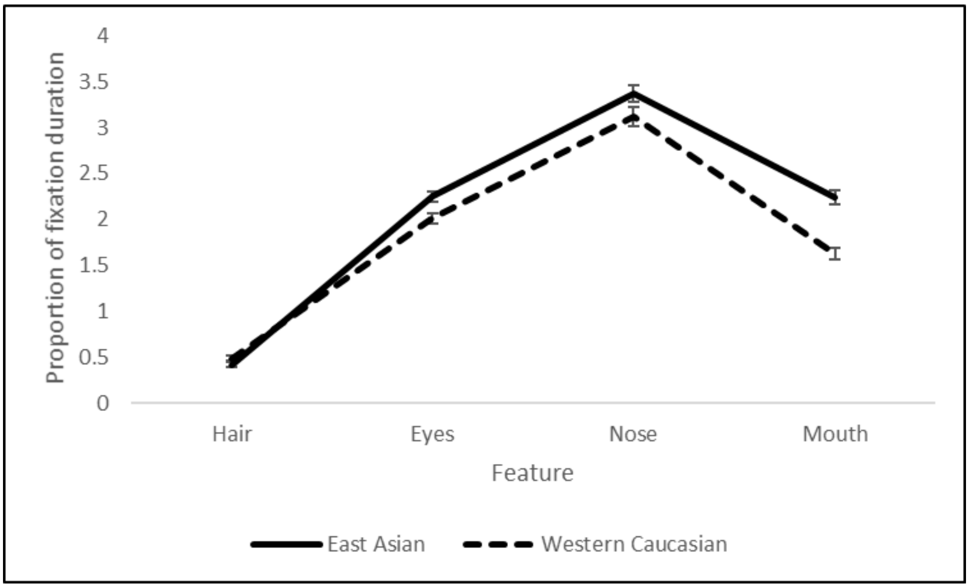


Figure 3.5 Proportions of fixation duration for Face Race and Feature interaction. Error bars represent standard errors of mean.

The three-way interaction for language, feature and nationality interaction was significant, $F(3, 183) = 2.72$, $p = 0.046$, $\eta_p^2 = 0.43$), supporting Hypothesis 1. To further elucidate this interaction, the data was split by nationality. A 2 (language) x 4 (feature) repeated-measures ANOVA was conducted on the split data. When split by nationality, the two-way interaction for language and feature was significant in the Malaysian data ($F(3, 114) = 2.90$, $p = 0.04$, $\eta_p^2 = 0.07$), and in the Austrian data ($F(3, 69) = 3.24$, $p = 0.03$, $\eta_p^2 = 0.12$). The main effect for feature was significant in the Malaysian data, $F(2.19, 83.11) = 171.76$, $p < 0.001$, $\eta_p^2 = 0.82$. Bonferroni-corrected pairwise comparisons show that the Malaysian Chinese participants looked more frequently at the nose than hair (mean difference = 5.32, $p < 0.001$), eyes (mean difference = 1.84, $p < 0.001$), mouth (mean difference = 2.45, $p < 0.001$); more frequently at the eyes than hair (mean difference = 3.48, $p < 0.001$); and more frequently at the mouth than hair (mean difference = 2.89, $p < 0.001$). There was no significant difference between the number of fixations on the eyes and mouth (mean difference = 0.59, $p = 0.14$). In summary, the Malaysian Chinese participants looked more frequently at the nose (*EMM* = 6.20, *SE* = 0.24), followed by the eyes (*EMM* = 4.36, *SE* = 0.12) and mouth (*EMM* = 3.77, *SE* = 0.16), followed by the hair (*EMM* = 0.88, *SE* = 0.05). Paired-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) showed no significant differences between the proportions of fixation duration on the hair ($t(38) = 1.89$, $p = 0.07$, $d = 0.25$), eyes ($t(38) = 1.76$, $p = 0.09$, $d = 0.36$), nose ($t(38) = 1.57$, $p = 0.12$, $d = 0.21$), and mouth ($t(38) = 0.47$, $p = 0.65$, $d = 0.08$) when speaking in English or Chinese. These results does not support Hypothesis 1 that cultural priming causes shifts in cognitive style.

The main effect for feature was also significant in the Austrian data, $F(2.18, 50.03) = 210.16$, $p < 0.001$, $\eta_p^2 = 0.90$. Bonferroni-corrected pairwise comparisons show that the Austrian Caucasians participants looked more frequently at the nose than hair (mean difference = 5.86, $p < 0.001$), eyes (mean difference = 2.62, $p < 0.001$), mouth (mean difference 2.83, $p < 0.001$); more frequently at the eyes than hair (mean difference = 2.43, $p < 0.001$); and more frequently at the mouth than hair (mean difference = 3.23, $p < 0.001$). There was no significant difference between the number of fixations on the eyes and mouth (mean difference = 0.21, $p = 1.00$). In summary, the Austrian Caucasian participants looked more frequently at the nose (*EMM* = 6.78, *SE* = 0.21) and eyes (*EMM* = 4.16, *SE* = 0.12) and mouth (*EMM* = 3.95, *SE* = 0.18), followed by the hair (*EMM* = 0.93, *SE* = 0.06). Paired-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) showed no significant differences in the proportion of fixations on the hair ($t(23) = 1.40$, $p = 0.18$, $d = 0.44$), eyes ($t(23) = 1.68$, $p = 0.11$, $d = 0.33$), and nose ($t(23) = 0.03$, $p = 0.98$, $d = 0.005$) when speaking English or German; no significant difference for the mouth was found after Bonferroni correction ($t(23) = 2.21$, $p = 0.04$, $d = 0.56$). See Table 3.6. Thus the Austrian data is in line with Hypothesis 1 that no cognitive shifts will occur when speaking in English and German.

Table 3.6
Means and standard deviations for the Language, Feature and Nationality interaction

	Feature							
	Hair		Eyes		Nose		Mouth	
Language	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Malaysian								
English	0.93	0.39	4.54	1.05	6.02	1.56	3.82	1.21
Chinese	0.84	0.34	4.18	0.97	6.38	1.77	3.73	1.11
Austrian								
English	1.02	0.54	4.27	0.71	6.79	1.32	3.63	1.30
German	0.84	0.26	4.05	0.63	6.78	1.03	4.28	0.99

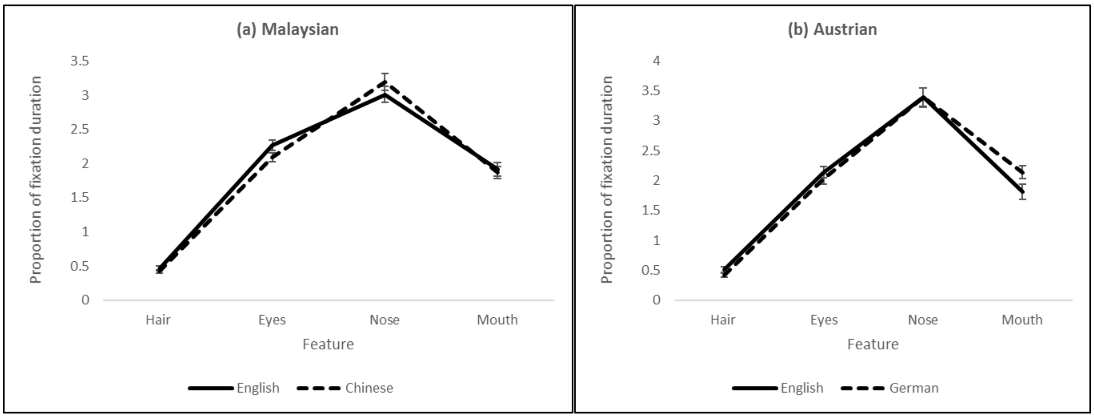


Figure 3.6 Proportions of fixation duration for Language and Feature interaction: (a) Malaysian data, (b) Austrian data. Error bars represent standard errors of mean.

Surprisingly, the three-way interaction for language, face race and feature was significant in the combined data, $F(2.23, 135.74) = 3.58$, $p = 0.03$, $\eta_p^2 = 0.06$. Separate 2 (race of face) x 4 (feature) repeated measures ANOVA were conducted for English and Chinese/German conditions. The interaction for race of face and feature was significant in both the English ($F(2.57, 151.51) = 8.40$, $p < 0.001$, $\eta_p^2 = 0.12$) and Chinese/German conditions ($F(2.18, 135.21) = 19.44$, $p < 0.001$, $\eta_p^2 = 0.24$). For the English condition, paired-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) showed that Malaysian and Austrian participants looked longer at

Asian eyes than Caucasian eyes (t(62) = 5.01, p < 0.001, d = 0.74), and longer at Asian mouth than Caucasian mouth (t(62) = 5.58, p < 0.001, d = 0.71). There were no differences for the proportions of fixation duration on Asian and Caucasian hair t(62) = 1.55, p = 0.13, d = 0.24) and nose (t(62) = 1.42, p = 0.16, d = 0.18) when speaking English. For the Chinese/German condition, paired-samples t-tests using Bonferroni-adjusted p values of 0.0125 per test (0.05/4) showed that Malaysian and Austrian participants looked longer at Caucasian hair than Asian hair (t(62) = 3.25, p = 0.002, d = 0.43), longer at Asian nose than Caucasian nose (t(62) = 2.54, p = 0.014, d = 0.34), and longer at Asian mouth than Caucasian mouth (t(62) = 8.15, p < 0.001, d = 1.18). No difference between the proportions of fixation duration for the eyes were found, t(62) = 0.92, p = 0.36, d = 0.12) when Malaysian and Austrian participants were speaking in Chinese or German, respectively.

Table 3.7
Proportions of fixation duration for the Language, Face Race and Feature interaction

	Feature							
	Hair		Eyes		Nose		Mouth	
Race of face	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
English								
East Asian	0.45	0.25	2.43	0.63	3.24	0.81	2.13	0.73
White Caucasian	0.52	0.32	2.00	0.52	3.08	0.94	1.62	0.71
Chinese/German								
East Asian	0.38	0.19	2.10	0.51	3.42	0.90	2.36	0.77
White Caucasian	0.45	0.16	2.04	0.49	3.11	0.92	1.58	0.55

Other interactions were not relevant to our hypotheses, all p's > 0.05.

3.3.2.3 Verbal descriptions

Language, feature and nationality. To test whether the description patterns across facial features differed according to the language spoken and race of face described, a 2 (language: English or Other Language [Chinese or German]) x 4 (feature: hair, eyes, nose or mouth) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged frequency of descriptions of the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

There was a main effect of feature ($F(2.06, 125.81) = 181.75$, $p < 0.001$, $\eta_p^2 = 0.75$). Bonferroni-corrected pairwise comparisons reveal more frequent descriptions of the eyes than of the hair (mean difference = 5.47, $p < 0.001$), nose (mean difference = 11.71, $p < 0.001$) and mouth, mean difference = 9.86, $p < 0.001$); more frequent descriptions of the hair than nose (mean difference = 6.25, $p < 0.001$) and mouth (mean difference = 4.40, $p < 0.001$); and more frequent fixations of the mouth than nose (mean difference = 1.85, $p < 0.001$). In summary, all participants described the eyes most frequently (*EMM* = 19.70, *SE* = 0.58), followed by the hair *(EMM* = 14.24, *SE* = 0.58), mouth (*EMM* = 9.84, *SE* = 0.38) and nose (*EMM* = 7.99, *SE* = 0.39).

An interaction effect of feature and nationality ($F(2.06, 125.81) = 10.08$, $p < 0.001$, $\eta_p^2 = 0.14$) was also found. Independent-samples t-tests using Bonferroni-adjusted *p* values of 0.0125 per test (0.05/4) showed that Austrian participants described the hair ($t(61) = 4.48$, $p < 0.001$, $d = 1.15$), nose ($t(61) = 3.10$, $p = 0.003$, $d = 0.81$) and mouth ($t(61) = 6.87$, $p < 0.001$, $d = 1.78$) more frequently than the Malaysian participants. There was no significant difference in the frequency of descriptions for eyes ($t(61) = 0.08$, $p = 0.94$, $d = 0.02$). This interaction was qualified by a significant three-way interaction of language, feature and nationality, supporting Hypotheses 1 and

3. Splitting by nationality, a 2 (language) x 4 (feature) repeated-measures ANOVA was conducted. The two-way interaction for language and feature was significant in the Malaysian ($F(1.65, 57.60) = 4.97$, $p = 0.015$, $\eta_p^2 = 0.12$) and Austrian data ($F(3, 78) = 4.27$, $p = 0.013$, $\eta_p^2 = 0.14$).

The main effect of feature was significant in the Malaysian data, $F(2.16, 75.48) = 124.29$, $p < 0.001$, $\eta_p^2 = 0.78$. Bonferroni-corrected pairwise comparisons show that Malaysian participants described the eyes more frequently than the hair (mean difference = 8.02, $p < 0.001$), nose (mean difference = 12.89, $p < 0.001$) and mouth (mean difference = 12.40, $p < 0.001$); and the hair more frequently than the nose (mean difference = 4.87, $p < 0.001$) and the mouth (mean difference = 4.38, $p < 0.001$). No difference between the frequency of nose and mouth descriptions were found (mean difference = 0.48, $p = 1.00$). In summary, Malaysian participants described the eyes most frequently, followed by the hair, and the nose and mouth. Paired-samples t-tests using Bonferroni-adjusted *p* levels of 0.0125 per test (0.05/4) show a nonsignificant trend that Malaysian participants described the hair more frequently when speaking in English than when speaking in Chinese ($t(35) = 2.56$, $p = 0.015$, $d = 0.27$), and described the nose more frequently when speaking in Chinese than when speaking in English $t(35) = 3.10$, $p = 0.004$, $d = 0.34$). No significant differences between the frequency of eyes ($t(35) = 1.02$, $p = 0.32$, $d = 0.19$) and mouth descriptions ($t(35) = 1.14$, $p = 0.26$, $d = 0.13$) were found when speaking English or Chinese. While there were more descriptions of the hair when Malaysian Chinese participants were speaking in English, and more descriptions of the nose in Chinese, there was no major shift towards Eastern- or Western-typical description strategies overall. Hypothesis 1 is partially supported.

The main effect for feature was also found in the Austrian data, $F(3, 78) = 75.65$, $p < 0.001$, $\eta_p^2 = 0.74$. The Austrian participants made more descriptions of the eyes than nose (mean difference = 10.54, $p < 0.001$) and mouth (mean difference = 7.32, $p < 0.001$), more descriptions of the hair than nose (mean difference = 7.62, $p < 0.001$) and mouth (mean difference = 4.41, $p < 0.001$), and more descriptions of the mouth than nose (mean difference = 3.21, $p < 0.001$). No significant difference between the frequency of hair and eye descriptions was found (mean difference = 2.92, $p = 0.07$). In summary, Austrian participants described the hair and eyes most frequently, followed by the mouth and nose. Paired-samples t-tests using Bonferroni-adjusted p levels of 0.0125 per test (0.05/4) show that Austrian participants described the hair ($t(26) = 4.59$, $p < 0.001$, $d = 0.78$), eyes ($t(26) = 3.62$, $p = 0.001$, $d = 0.73$) and nose ($t(26) = 2.79$, $p = 0.01$, $d = 0.56$) more frequently when speaking in German than in English; mouth descriptions were also described marginally more significantly ($t(26) = 2.04$, $p = 0.051$, $d = 0.47$) in German than in English. These description patterns may have been driven primarily by the Austrians' better proficiency in German, or constraints in both languages, resulting in more descriptions in German than English, though descriptions in both language follow the same pattern. See Figure 3.6.

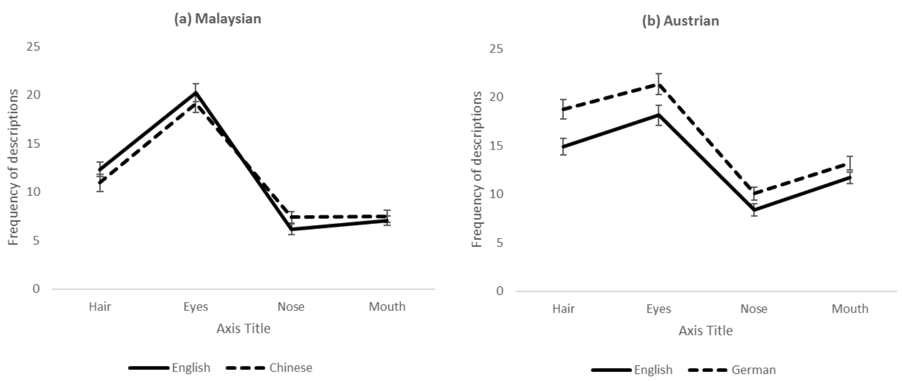


Figure 3.7 Frequency of descriptions for Language, Feature and Nationality interaction: (a) Malaysian data, (b) Austrian data. Error bars represent standard errors of mean.

Language, description type and nationality. To test whether the frequency of featural or configural descriptions differed according to the language spoken, a 2 (language: English or Other Language [Chinese or German]) x 2 (description type: featural or configural) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged frequency of descriptions of the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

The main effect for description type was significant, $F(1, 61) = 823.36$, $p < 0.001$, $\eta_p^2 = 0.93$. Pairwise comparisons show that all participants made more featural ($EMM = 46.48$, $SE = 1.39$) than configural descriptions ($EMM = 5.29$, $SE = 0.36$).

The interaction for language, description type and nationality was marginally significant, $F(1, 61) = 3.78$, $p = 0.056$, $\eta_p^2 = 0.06$. Splitting by nationality, the interaction for language and description type was nonsignificant in the Malaysian data ($F(1, 35) = 0.28$, $p = 0.60$, $\eta_p^2 = 0.008$), but significant in the Austrian data ($F(1, 26) = 4.22$, $p = 0.05$, $\eta_p^2 = 0.14$), contrary to our predictions. Pairwise-comparisons show that Malaysian participants made significantly more featural ($EMM = 42.16$, $SE = 1.97$) than configural descriptions ($EMM = 3.16$, $SE = 0.47$). Paired-samples t-tests using Bonferroni-adjusted p values of 0.0125 per test (0.05/4) show no differences in the frequency of featural descriptions when Malaysian participants were speaking in English or Chinese ($t(35) = 0.49$, $p = 0.63$, $d = 0.07$), and no differences in the frequency of configural descriptions when speaking in English and Chinese ($t(35) = 0.16$, $p = 0.87$, $d = 0.02$).

Austrian participants also made significantly more featural ($EMM = 50.80$, $SE = 1.86$) than configural descriptions ($EMM = 7.43$, $SE = 0.57$). Paired-samples t-tests using Bonferroni-adjusted p values of 0.0125 per test (0.05/4) show that Austrian participants made significantly more featural descriptions ($t(26) = 3.43$, $p = 0.002$, $d = 0.66$) and more configural descriptions ($t(26) = 3.58$, $p = 0.001$, $d = 0.79$) when speaking in German than English.

Other effects were irrelevant to our hypotheses. The main effect for language in the Malaysian data was nonsignificant, $p = 0.67$. The main effect for language was significant in the Austrian data, $F(1, 26) = 18.51$, $p < 0.001$, $\eta_p^2 = 0.42$, where descriptions in German ($EMM = 31.67$, $SE = 1.23$) were made significantly more frequently than descriptions in English ($EMM = 26.57$, $SE = 0.97$).

Face race and feature. To test whether the frequency descriptions for facial features differed according to the race of face, a 2 (race of face: East Asian or Western Caucasian) x 4 (feature: hair, eyes, nose or mouth) repeated-measures ANOVA was conducted on the averaged frequency of descriptions of the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

While the main effect of feature was significant ($F(2.01, 124.87) = 167{,}91$, $p < 0.001$, $\eta_p^2 = 0.73$), the interaction of race of face and feature was nonsignificant ($F(3, 186) = 1.39$, $p = 0.25$, $\eta_p^2 = 0.02$), suggesting no differences in description strategy by race of face, and therefore not supporting Hypothesis 3. Bonferroni-corrected pairwise comparisons reveal more frequent descriptions of the eyes than of the hair (mean difference = 5.83, $p < 0.001$), nose (mean difference = 11.88, $p < 0.001$) and mouth, mean difference = 10.23, $p < 0.001$); more frequent descriptions of the hair than nose (mean difference = 6.05, $p < 0.001$) and mouth (mean difference = 4.39, $p < 0.001$); and more frequent fixations of the mouth than nose (mean difference = 1.67, $p < 0.001$). In summary, all participants described the eyes most frequently ($EMM = 19.70$, $SE = 0.57$), followed by the hair (*EMM* = 13.87, *SE* = 0.67), mouth (*EMM* = 9.47, *SE* = 0.49) and nose (*EMM* = 7.82, *SE* = 0.42).

Face race and description type. To test whether the frequency of featural or configural descriptions differed according to the race of face, a 2 (race of face: East Asian or White Caucasian) x 2 (description type: featural or configural) repeated-measures ANOVA was conducted on the averaged frequency of descriptions of the hair, eyes, nose and mouth area for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

The main effect of description type was significant, $F(1, 62) = 810.51$, $p < 0.001$, $\eta_p^2 = 0.93$. Pairwise-comparisons show significantly more featural descriptions (*EMM* = 45.86, *SE* = 1.47) than configural descriptions (*EMM* = 4.99, *SE* = 0.45).

The interaction for race of face and description type was significant, $F(1, 62) = 6.74$, $p = 0.01$, $\eta_p^2 = 0.10$. Paired-samples t-tests using a Bonferroni-adjusted *p* values of 0.025 (0.05/2) show no differences in the frequency of featural descriptions for East Asian and White Caucasian faces ($t(62) = 1.64$, $p = 0.11$, $d = 0.12$). More configural descriptions for East Asian faces were found compared to that of White Caucasian faces ($t(62) = 3.57$, $p = 0.001$, $d = 0.30$), supporting Hypothesis 2 that descriptions are influenced by race of face.

3.4 Discussion

3.4.1 Cultural primes and cognitive style

The Austrian participants provided significantly more featural descriptions than configural descriptions across both language conditions, and there was no significant interaction between description type and language. There was no effect of language/cultural priming on looking strategy, in line with our predictions.

However, in the Malaysian sample, the eye-tracking data do not support Hypothesis 1 that Malaysian Chinese participants will use a more configural looking strategy when speaking in Chinese, because the frequency or duration of fixations did not differ significantly between language conditions. Similar to Tan et al. (2012), Malaysian Chinese participants fixated on the eyes and nose the most. The eye-tracking results do not support the cultural explanation, as language priming did not lead to a shift in mindset when looking at faces.

Instead we found that participants fixated more and longer on White Caucasian hair, suggesting that participants looked at features that were more diagnostic for identification, due to the variety in White Caucasian hair colours as compared to that of East Asians. This finding thus partially supports the facial information hypothesis that looking strategy is influenced by variances in facial appearance, but does not support the cultural explanation that individuals' cultural backgrounds influence their perceptual style and the way they fixate on faces. This is in contrast to the results of Tan et al (2012), who did not find significant differences in the fixation patterns used to recognise faces of different races. It should be noted, however, that the tasks differed in significant ways – namely, while the current study used 60 second presentations of the face stimuli, and the participants described the faces, Tan et al. (2012) used 5 second presentations in a face recognition paradigm. It may be that the shorter presentations used by Tan et al. (2012) did not allow enough time for these differences to emerge. Alternatively, it may be that the differences in the task (describing vs. recognising) may have driven these different results.

Contrary to the prediction of the cultural explanation, Malaysian participants provided significantly more featural than configural descriptions in both language conditions, and no interaction between language and description type was found, indicating that participants did not make more configural descriptions when speaking Mandarin than when speaking English. This suggests that linguistic/cultural priming may not have impacted on the featural/configural processing of participants. However, there were some differences in the descriptions made by participants when speaking English and when speaking Mandarin. Participants made more descriptions of the hair when speaking English, and more descriptions of the nose when speaking Mandarin. This may reflect different linguistic conventions and different linguistic constraints of the two languages, rather than a shift in cultural mindset.

3.4.2 If looking and description strategy is determined by diagnostic features

Neither looking strategy nor description style was found to follow distinctly configural or featural patterns. Malaysian Chinese participants maintained their unique intermediate pattern, and provided significantly more featural than configural descriptions. However, participants looked longer and more frequently at White Caucasian hair, possibly due to the greater variance in colour. This is consistent with the facial information hypothesis.

Our findings are inconsistent with Ellis et al. (1975), who found more frequent configural descriptions by Black African participants who are exposed to faces with predominantly dark-coloured hair and eyes. However, that there is a trend suggesting that more featural descriptions are made of Caucasian than of Asian faces lends some weak support to the face appearance explanation. This hypothesis is partially supported.

In the Austrian participants, we initially predicted that if looking and description strategy is determined by the diagnostic features of faces, then looking strategy and description strategy would change according to race of face.

Austrian participants fixated more on the hair region of White Caucasian faces than on East Asian faces, suggesting that participants may adjust their looking strategy according to the diagnostic features of the different races of face. The results indicate that the Austrian participants fixated more on Caucasian hair than Asian hair. This suggests that there may be an impact of face ethnicity on looking strategy and description pattern. Some support is found for this hypothesis.

Our results suggest that, while looking strategy is susceptible to race of face effects, verbal descriptions may not be.

3.4.3 If descriptions are bound by language

As aforementioned, Malaysian participants provided significantly more featural than configural descriptions whether they were speaking in English or Chinese, while maintaining similar fixation patterns for both language conditions. However, more hair descriptions in the English language condition and more nose descriptions in the Chinese language condition were found. We suggest that these differences could have arisen due to some features being easier to describe in one language and not the other.

In the Austrian sample, in line with our predictions, more featural descriptions were provided in both language conditions than configural descriptions. More descriptions in German were mentioned across all features, probably due to the Austrian participants being more comfortable speaking in German.

We also found that participants' verbal descriptive strategy differed according to the language that was being spoken. While participants made more descriptions of all AOIs when speaking German than when speaking English, this effect was larger when describing hair and eyes than when describing nose and mouth.

This hypothesis that descriptions are bound by language is partially supported.

3.4.4 Chapter discussion

The key findings from this sample of Malaysian Chinese and Austrian Caucasians suggest that looking patterns during a face description task are influenced by the race of face, but not by linguistic priming. Conversely, patterns of descriptions are influenced by language, but not the race of face. This therefore does not support the hypothesis that cultural primes cause shifts in face processing style, but rather suggests that looking strategy is influenced by the diagnostic information in the target faces, and that description patterns are bound by language.

While previous studies have claimed to have identified shifts in cognitive styles as bilingual participants shift between languages, these studies have tended to use exclusively verbal tasks in order to assess this proposed cognitive shift (Hong et al., 2000; Marian & Neisser, 2000). For example, Marian & Kaushanskaya (2007) found that bilingual Hong Kong Chinese participants answered culturally ambiguous questions with answers appropriate to Chinese culture when speaking Chinese, and with answers appropriate to Western culture when speaking English. Pavlenko (2003) found a similar pattern in Russian immigrants to the United States. In the current study, we replicated a shift in verbal responses when Malaysian Chinese participants switched between English and Mandarin, and Austrian Caucasian participants switched between English and German. However, we failed to find any impact of linguistic priming on looking strategies. This suggests that, rather than a shift in cognitive style resulting from linguistic priming, it may be that changes in verbal responses may be attributable to differences in language or in learned responses.

However, a looking strategy similar to the Malaysian Chinese sample (i.e. more fixations to the eyes and nose regions) was found in the Austrian Caucasian sample, inconsistent with previous findings of featural patterns previously found in in White

Caucasian samples (Blais et al., 2008; Jack et al., 2009). The resulting eye-tracking patterns could have been due to the nature of the task in which the duration of each trial was 60s, compared to shorter trials of 5s per image in previous studies (Blais et al., 2008; Tan et al., 2012). As such it might be useful to examine the effect of viewing time on looking pattern. It should also be noted that the current experiment had participants describing the faces while looking at them, which may have led to a switch to more featural processing style (Schooler & Engstler-Schooler, 1990).

The current results demonstrate that individuals' looking strategies differ according to the race of face they are looking at. Since the systematic variance in face shape is known to be concentrated in different areas of the face in East Asian than in Caucasian populations (Le, Farkas, Ngim, Levin, Forrest, 2002), our results suggest that different looking strategies may be advantageous when looking at different race faces. Fu, Hu, Wang, Quinn and Lee (2012) found that mainland Chinese participants fixate more on the eyes of Caucasian faces, and on the nose and mouth of Chinese faces in a face recognition task. Hills and Lewis (2006) found that training White Caucasian participants to focus on the lower features (instead of the eyes) enhanced recognition accuracy of Black African faces, suggesting that the lower features of African faces are more diagnostic of identity than the upper face. Our results suggest that participants are able to adjust their looking strategy to better suit recognition of faces of different ethnicities. However, while black African participants have been found to describe the lower face more than the upper face in description tasks (Ellis et al., 1975), this concordance between looking patterns and description patterns was not found in the current study. Instead a substantial difference was found in the pattern of features that were described, compared to the features that were fixated upon. We offer two possible explanations for this.

Firstly, that the features being fixated upon do not map directly onto the features being processed, due to global processing of information. It is thought that fixating on the middle of the face (nose region) does not necessarily represent a focus on the characteristics of the nose, but rather that it represents a more configural processing style, such that information is being extracted from the face as a whole (Blais et al, 2008). It is known that a shift towards local processing occurs when verbalising (Schooler & Engstler-Schooler, 1990), so it may be that the difference in looking strategies may represent a difference between the more featural task of describing faces and the more configural task of processing facial information. Some support is found for this hypothesis in the fact that we find significantly more featural than configural descriptions used in the current study.

Second, it may be that people make descriptions that are easier to express in language, rather than making descriptions that would be more useful to the receiver of the information in identifying the target face. It may be easier, for example, to describe the colour of a target's hair than to describe the angle of their jawline or the distance between their eyes. This hypothesis may be supported by the fact that we find significant differences in the pattern of descriptions used when speaking in English than when speaking Mandarin. It may be that differences inherent in the different languages (for example differences in vocabulary or grammatical structures) make it easier to describe certain features in one language than in the other. Cross-linguistic studies have shown some support for linguistic constraints, for instance, with generic noun phrases in English and Mandarin (Gelman & Tardif, 1998), and colour discrimination in Russian and English (Winawer, Witthoft, Frank, Wu, Wade, & Boroditsky, 2007), where the nature of one language (e.g. grammatical structure) impacts on how certain concepts are expressed. Conversely, it may be that the linguistic conventions of describing faces in different languages have developed to best describe the faces of the dominant ethnicity in the culture. More research is required to test this hypothesis, however.

All in all, our results do not support the Sapir-Whorf Hypothesis that language influences cognition, inconsistent with previous studies in which priming language led to shifts in cognitive style (Hong et al., 2000; Marian & Neisser, 2000; Pavlenko, 2003). We postulate that describing facial features may be too direct a task to cause a cultural switch, and that this effect might be elicited more saliently with abstract concepts, e.g. inferring personal characteristics or scene description. While we suggest that some features may be easier to describe in one language than another, we know of no studies on cross-linguistic differences in language constraints, i.e. what is easier said in one language than another.

Another possibility is that the manner in which individuals describe is also dependent upon the audience, because the describer is assuming different cultural backgrounds and assumptions. For example, the way in which a Chinese person describes a face to another Chinese person could be different from the way a Chinese person would describe the same face to a Caucasian person. However, at present there is no research to support these suggestions.

In conclusion then, we have found support for the hypothesis that linguistic priming impacts on responses to verbal tasks. However, our results have failed to support the Sapir-Whorf hypothesis that cognitive patterns are dependent on the language being used, since the fixation patterns used when looking at faces did not differ between either the Mandarin and English, or German and English iterations of the task. We did find evidence that individuals change their looking strategy in response to the race of face being observed. This provides support for the hypothesis that different looking strategies are effective at distinguishing between individuals of different races. Finally, we find that the pattern of fixations does not match the pattern of descriptions used in our face description task. We propose two hypotheses for this discrepancy, and further research is required to ascertain which may be correct.

Limitations

One limitation may be noted for the current study. Firstly, while the Malaysian participants were truly bilingual, showing approximately equal proficiency in English and Mandarin, the Austrian participants were native German speakers who were also fluent in English, and as such, their German proficiency was better than their English.

3.4.5 Conclusion

In conclusion, our main findings are that: 1) using language as a cultural prime does not lead to a shift in featural/configural perceptual styles; 2) Fixation patterns are influenced by facial appearance, thereby supporting the facial information hypothesis; 3) verbal descriptions of facial features are influenced by language.

Chapter 4
Do language and culture affect scene processing strategies?

4.1 Introduction

4.1.1 Perceptual differences between EA and WC in scene perception

In Chapters 2 and 3, strong evidence of cognitive and perceptual differences between East Asian and White Caucasian participants have been outlined, with East Asian participants showing a more holistic cognitive style, compared to White Caucasians' more local processing style. Here, further differences in the scene perception literature will be discussed.

Previous studies have shown strong evidence that East Asians tend to be more susceptible to changes in contextual information, e.g. the background objects of a scene, while White Caucasians are more susceptible to changes in the focal objects within a scene. In a study of the classic rod-and-frame illusion by (Ji et al., 2000), a square frame containing a rod was used, where both the rod and frame could be adjusted independently. Participants were asked to stop the experimenter from turning the rod when the rod was straight. White Caucasians performed better on a task which involved participants judging or rotating a rod until it appears to be vertical regardless of the orientation of the frame. The East Asians who were more dependent on the angle of the frame performed less well in comparison.

This dependence on contextual information is further demonstrated by Kitayama et al. (2003), who presented Japanese and American participants with a square frame, in which a line was drawn. Other square frames of various sizes were then shown, in which participants drew a line that was identical to the first line in either absolute length or ratio to the surrounding frame. Kitayama et al. found that American participants were more accurate in the absolute task, while Japanese participants were more accurate in the relative task, thus suggesting that the Japanese participants were paying more attention to contextual information than the American participants.

The role of attention in bilinguals

Further evidence of perceptual differences between East Asians and White Caucasians has been shown in change blindness studies, in which certain aspects of a scene are altered in subsequent viewing tasks. Masuda & Nisbett (2005) found that American participants were more sensitive to changes in foregrounded objects than backgrounded information, and vice versa for the Japanese participants who were more sensitive to changes in the background than the Americans.

An earlier study by Masuda & Nisbett (2001) in which a recognition task required Japanese and American participants to identify previously seen objects on their original or novel backgrounds showed that the Japanese participants were more susceptible to changes in the background, while the object recognition accuracy of the American participants was relatively less affected by the change in backgrounds.

Using a visual change detection paradigm in Bodoroglu, Shah, and Nisbett (2009), East Asian and American participants were asked to decide whether there was a colour change between the first and second displays of four coloured blocks in a quadrant, and instructed to make a key press as soon as they detected a central square on certain trials. Bodoroglu et al. found that East Asians were faster at identifying colour changes when the background layout was expanded to cover a wider region and worse when the background area was shrunk, but slower than Americans at identifying changes which occurred in the middle of the screen, thus suggesting that East Asians spread their visual attention more broadly than do Westerners.

4.1.2 Eye-tracking studies

Recent eye-tracking studies have also shown that East Asians tend to focus their visual attention (e.g. make more or longer fixations) more onto the background, while White Caucasians pay more attention to focal objects, when presented with static stimuli in passive-viewing tasks (Chua et al., 2005; Goh et al., 2009).

Chua et al. (2005) presented Mainland Chinese and American participants with a series of pictures with single foregrounded objects on realistic backgrounds. American participants were found to fixate more on the foregrounded objects than the Mainland Chinese participants, who made more fixations on the background.

Similarly, Singaporean Chinese and Americans used similar looking patterns in a passive-viewing task of pictures with focal objects on realistic-looking natural backgrounds (Goh et al., 2009). While both groups were found to respond to focal object changes, the number of object fixations in the American participants was more affected by object change than in the Singaporean Chinese participants. Goh et al. (2009) also found that despite the picture manipulations, the American participants consistently maintained longer durations for fixations on the object and background, while their eye movements generally remained within the focal objects. The Singaporean Chinese, in comparison, made shorter fixations that alternated more between focal objects and backgrounds.

Some studies however, have found no cultural differences in scene perception. Evans, Rotelli, Li and Rayner (2009) reported similar eye movements across both American and Chinese participants. Both groups made more and longer fixations on the focal objects than the backgrounds. Similarly, Miellet, Zhou, He, Rodger, and Caldara (2010) did not find an effect of culture on extrafoveal information use during an ecologically valid visual search task of animals in natural scenes. They presented scenes containing animals to Eastern and Western participants. A “blindspot” was overlaid on the images such that the region on which the participants were foveating was not visible. This blindspot followed the participants’ eye movements so that only information from the extrafoveal vision could be used. Participants were asked to identify the animals. No significant difference in the animal recognition ability of the two groups was found, suggesting that individuals from Eastern and Western cultures are able to use extrafoveal information equally effectively.

4.1.3 Contextual preferences

It has been argued that East Asians’ higher dependence on contextual information could have arisen from the perceptual environment typical of the local culture (Miyamoto, Nisbett, & Masuda, 2006); if the local environment was more ambiguous (i.e. the objects were more difficult to distinguish from the background), then there would be a higher dependence on contextual information. Street scenes of landmarks (hotels, schools and post offices) located in small, medium and large cities in Japan and the US were taken, and participants rated on Likert scales the ambiguity of each scene. Pictures of Japanese scenes were found to be more ambiguous and contain more objects than American scenes. Miyamoto et al. also found that American and Japanese participants who were primed with Japanese scenes attended more to contextual information, further lending support that scene ambiguity may encourage increased attention to context.

In line with these results are the aesthetic preferences in art styles and photographs produced by East Asians and White Caucasians (Masuda, Gonzalez, Kwan & Nisbett, 2008). Masuda et al. examined the content of traditional art styles produced by East Asian and Western artists using archival records, as well as how contemporary East Asian and Western artists drew and took landscape and portrait photographs. They concluded that contemporary East Asian art styles were more context-inclusive than the Western art styles which were more object-focused. These culture-specific preferences for contemporary context- and object-based drawings and photos were consistent with what was prevalent in the traditional styles.

Further, East Asians' preference for richer contextual information is demonstrated by Wang, Masuda, Ito, and Rashid (2012). The preferred amount of information contained in cultural products (in this case, conference posters and government websites) produced by East Asian and North Americans in two contexts, and the speed at which both groups searched for information on mock webpages was examined. In general, East Asians were found to produce more information-rich products than the North Americans, and tended to be faster at searching for information on mock webpages containing large amounts of information.

It would be reasonable then, to think that East Asians' descriptions of scenes could be influenced by this increased dependency on contextual information. Alternatively, the ambiguity of scenes in Asian cities (Miyamoto et al, 2006) encourages more configural perceptual styles.

4.1.4 Scene description and linguistic/cultural priming

If more attention is paid to contextual information, it is predicted that participants should make more descriptions of background areas in a scene. Conversely, if more attention is paid to focal objects then descriptions should be focused on these areas.

In Masuda and Nisbett (2001), American and Japanese participants viewed and described animated vignettes of underwater scenes, each containing a large "focal fish" with salient colours and shapes, moving in a complicated scene consisting of smaller “background fish”, inert animals, active animals, plants, and bubbles etc. The description data was coded according to a set of rules to categorise featural and configural descriptions. Masuda and Nisbett found that Japanese participants made more configural descriptions (e.g. there is a small fish swimming towards the big fish), while the American participants made more featural descriptions (e.g. there is a big fish). The first descriptions that the Japanese and Americans reported also corresponded to these differences.

Further, East Asians have been found to make more reference to context when making explanations relative to Westerners, for instance in self-descriptions (Kanagawa et al., 2001; Ross et al., 2002). The types of self-descriptions used (positive or negative) by Japanese participants’ were more impacted by the presence of others – they made more negative self-descriptions when in the presence of others – than did the Americans (Kanagawa et al., 2001). Chinese-Canadian students made more collective self-statements when describing themselves in Chinese than in English (Ross et al 2002), suggesting that they are more concerned about the context of their comments when speaking Chinese than when speaking English.

As discussed previously in Chapter 3, bicultural individuals have been known to frame-switch between cultural mindsets with which they are familiar (Luna et al., 2008). Differences in description patterns have been found when bilingual/bicultural participants describe the same stimuli, when primed to speak in different languages. It has been postulated by the Sapir-Whorf Hypothesis (Whorf, 1956) that language impacts on cognition. This hypothesis is supported by the results of a number of studies. Descriptions have tended to reflect more collectivistic patterns when primed in Chinese. Chinese born Canadians who were assigned to respond in Chinese provided more collectivistic self-statements in open-ended self-descriptions, lower self-esteem on the Rosenberg scale, and more agreement with Chinese cultural views than the control participants or Chinese-born Canadians assigned to respond in English (Ross et al., 2002).

More specifically to the current study, Hong Kong Chinese participants primed with photos of culturally-significant icons of Chinese culture and American culture (e.g. the Great Wall vs. the Capitol building) exhibited more characteristics typical of collectivistic culture when speaking in Chinese (Hong et al., 2000).

Pavlenko (2003) found that when bilingual Russian/English participants were primed in English and were asked to describe a video (of a man approaching a woman at a park) in English, concepts such as “privacy” and “personal space” not prevalent in Russian culture were mentioned significantly more frequently in English.

Conversely, in a study by Choe et al. (2015), Korean and English participants described a set of dynamic scenes at two different presentation durations, and then recalled the focal figures and backgrounds of the depicted situations. Inconsistent with the findings of other studies (e.g. Hong et al., 2000), however, English speakers made more descriptions of background details while Korean speakers made more descriptions about figures at longer durations. However, in the recall task, Korean speakers remembered background information more accurately. These studies suggest, therefore, that bilingual participants’ processing of information, reflected in their descriptions of scenes, and even of themselves, changes depending on the language spoken and culture primed.

Following the study on faces in Chapter 2, we aim to examine the extent of linguistic/cultural priming in looking and description strategy in scenes as a comparison.

4.1.5 Neural processing of faces vs. scenes

While studies involving descriptions of concepts such as the self (Kanagawa et al, 2001; Ross et al, 2002), answering general knowledge questions (Hong et al., 2000) or describing activities occurring in videos (Pavlenko, 2003) have found "frame-switching" effects of switching between Western and Eastern languages in bilingual individuals, previous studies have not attempted to identify changes in looking strategy when completing tasks in different languages. In Chapter 3, we did not find such an effect of speaking in Chinese or English on the looking strategies of participants in a face description task (although some differences in descriptions were found between Mandarin and English).

It is thought that face processing may be a "special case" of perception, with evidence that faces are processed more holistically than non-face objects (Richler et al., 2009). It is thought that face processing follows specific neural networks in the brain, and that the fusiform face area is specialised for face perception (Kanwisher, McDermott, & Chun, 1997). Indeed, cases have been described of prosopagnosics who are able to distinguish between non-face objects normally, while being unable to recognise individual faces (Riddoch et al, 2008). It may be the case, therefore, that face processing is also a special case in relation to the Sapir-Whorf hypothesis, and be less susceptible to cultural/linguistic priming. The present study is therefore a comparison study using more ambiguous, naturalistic images such as street scenes similar to Miyamoto et al.'s (2006) study. In this study we aim to further examine whether an effect of linguistic/cultural priming on looking and description strategy can be found in non-face stimuli, and thereby determine whether faces are indeed likely to be a special case in this respect.

In this study we will use the same cultural-priming method from Chapter 3 to prime bilingual Malaysian Chinese/English participants who describe Asian and European street scenes in English and Chinese, as well as a comparison group of bilingual Austrian German/English participants who will describe the same scenes in English and German.

We will describe in Study 1 the Methods and Results from the Malaysian Chinese data, and the same for the Austrian data in Study 2.

4.1.6 Hypotheses

If cognitive frame-switching can be induced using a cultural/linguistic prime, we predict:

1. Malaysian Chinese participants will show more configural and less focal-object based looking and description patterns when participants are speaking in Chinese, and more focal-object based looking and description patterns when speaking English.
2. Austrian participants will not show a shift in looking and description patterns when speaking in English compared to German, since both languages come from individualistic societies.

However, if looking and description patterns are determined by the stimulus, we predict:

3. Austrian and Malaysian participants will show more configural looking and description patterns when describing Asian scenes, and more focal-object based looking and description patterns when describing European scenes.

4.2 Methods

Two sets of bilingual participants: Malaysian Chinese participants bilingual in Mandarin and English, and Austrian Caucasian participants bilingual in German and English, were asked to describe a series of Asian and European street scenes, and the audio of their descriptions was recorded. Their eye movements were also recorded. Participants completed the task (with different scenes) twice – once in English following an English cultural prime, and once in Mandarin, following a Chinese cultural prime (Malaysian sample) or German following a Germanic cultural prime (Austrian sample).

4.2.1 Design

A 2 (language: Mandarin/German or English) x 2 (location: Asian or European) x 2 (AOI type: focal or nonfocal) x 2 (nationality: Malaysian or Austrian) mixed design was used. The dependent variables were the total number of fixations and total duration of fixations for the eye-tracking data, and description frequency for verbal descriptions.

4.2.2 Participants

Malaysian Chinese Sample

26 Malaysian Chinese participants consisting of 12 males (44.4%) and 15 females (55.6%), mean age = 22.48 (SD = 2.58), who speak fluent English and Chinese (Mandarin) were recruited from the University of Nottingham Malaysia Campus. All participants had normal or corrected-to-normal vision, and received course credit or RM10 for participation. All protocol was approved by the University of Nottingham Malaysia Campus ethics committee.

Austrian Caucasian Sample

Thirty-four (17 male, 17 female; mean age = 24.06, SD = 2.23) bilingual German/English Austrian Caucasian participants were recruited from the University of

Vienna, Austria. All participants had normal or corrected-to-normal vision, and received either course credit or candy for their participation.

4.2.3 Language History

Upon completion of the language priming tasks, participants were given a language history questionnaire (adapted from Li, Sepanski, & Zhao, 2006) to complete, in which they provided details of their proficiency (on a 7-point Likert scale) in reading, speaking, writing and understanding English, Mandarin/German, and other languages they know; years spent learning these languages; and the estimated number of hours per day for which they speak each language.

For the Malaysian Chinese sample, the mean rating for English spoken proficiency was 4.95 ($SD = .89$) and the mean rating for Chinese spoken proficiency was 6.05 ($SD = .89$). Two participants (7.4%) reported speaking English as their first language and 18 participants (66.7%) reported speaking Mandarin as their first language. Seven participants (25.9%) provided missing values.

For the Austrian sample, the mean rating for English spoken proficiency was 5.15 ($SD = .74$). All participants rated German as their native language ($M = 7.00$, $SD = .00$).

4.2.4 Materials

Stimuli for the cultural priming consisted of the information sheet, consent form and music video in the target language. The photographic stimuli were used in the verbal description task.

4.2.4.1 Information sheet and consent forms

The same forward- and back-translated procedures as described in Chapter 3.2.3.1 were used.

4.2.4.2 Music videos

The same English, Chinese and German-language videos as described in Chapter 3.2.3.2 were used.

4.2.4.3 Photographic stimuli

The photographic stimuli for Experiments 1 and 2 consisted of 16 street scenes (8 Asian, 8 European). Following Miyamoto, Nisbett, and Masuda (2006) who used landmarks (hotels, post offices and schools) in large and small towns as stimuli, we obtained screenshots from Google Street View of hotels across four price categories (budget, midrange, upscale and luxury), using the custom filter for hotels on TripAdvisor.com, to include a diverse sample of street scenes. Hotels were sampled from Singapore and Berlin, so that the street scenes would be similar in architectural style but not overly familiar to the Malaysian and Austrian participants respectively. Any car registration plates, identifiable persons and certain buildings have been blurred by default on Google Street View.

4.2.3.4 Eye tracking

The same eye-tracking methods as described in Chapter 3.2.3.4 were used.

4.2.5 Procedure

The experiment consisted of two language blocks. The order of presentation of language blocks was counterbalanced between participants. Within each language block, all participants completed the following procedures:

4.2.5.1 Language priming

Participants were given an information sheet (in Chinese/German or English) to read, understand and indicate their consent to participate. After completing the consent form, participants watched a music video of a pop song in the same language as the instructions. The experimenter spoke to the participant in only the language of the current block throughout.

4.2.5.2 Scene eye-tracking and description

Eight scenes (4 Asian, 4 European, 50% low-end consisting of budget and mid-range hotels, 50% high-end consisting of upscale and luxury hotels) were presented on the screen. The image stimuli extended a visual angle of 32.95° (horizontal) and 11.99° (vertical). The scenes from each location were presented in two separate blocks, with the order of Asian and European scenes counterbalanced; within each block, the order in which the four scenes are presented was randomised. A fixation cross preceded each trial; each trial appeared on screen for 60s. Participants were asked to describe each scene, in the same language as the language block currently being completed, in as much detail as possible (imagining that they were describing the scenes to the police), and to use the full minute.

These two tasks were then repeated in the other language (e.g. English block followed by Chinese/German block, or vice versa). A different set of eight scenes was used in the second half of the experiment, to avoid participants describing the same scenes more than once. See Figure 4.1.

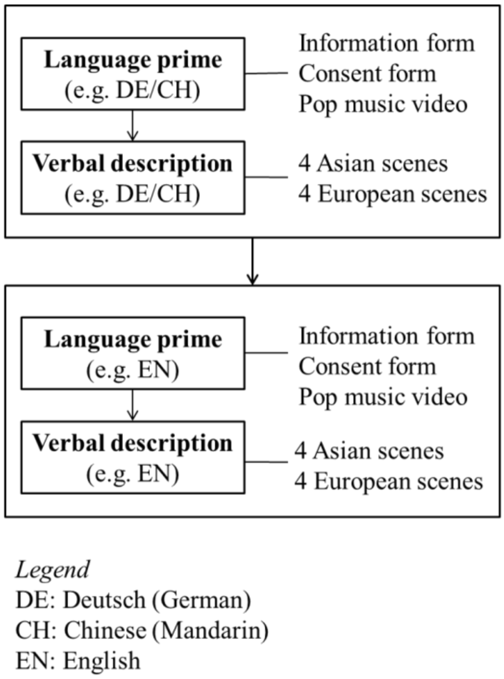


Figure 4.1 Flow chart of the experimental procedure.

4.3 Results

4.3.1 Data analysis

4.3.1.1 AOI analysis

Malaysian Chinese sample. Objects within each scene were drawn on Tobii Studio to define as many different objects as possible, ensuring that the lines drawn to delineate the edges were drawn as close to the objects as possible, using the LabelMe dataset as a guide (Russell, Torralba, Murphy, & Freeman, 2008).

To ascertain which objects within a scene were focal or nonfocal, an independent set of 14 participants who were blind to the hypotheses were recruited to validate the focal points for each scene via a Qualtrics online questionnaire, using the heat map function. In the questionnaire, focal objects were defined as “an object or area that is prominent in a scene, e.g. something eye-catching or that can be noticed immediately." Participants were instructed to click on what they deemed as focal objects, and were allowed up to ten clicks per image. The order of the blocks in which the Asian and European scenes were presented to participants was randomised.

Based on the questionnaire responses, we categorised the AOIs in each scene into Focal or Nonfocal objects. An AOI is considered as a focal object if more than 30% of the participants clicked on it. The same focal points apply for the Malaysian and Austrian participants' data.

There was an average of 13.13 AOIs per scene, across all Asian and European scenes. There was an average of 2.62 (SD = .52) focal AOIs and 9.38 (SD = 4.50) nonfocal AOIs per Asian scene, and an average of 2.38 (SD = 1.06) focal AOIs and 11.88 (SD = 3.14) nonfocal AOIs per European scene. Thus, the number of focal ($t(14)=.57$, $p=.575$) and nonfocal ($t(14)=1.29$, $p=.218$) AOIs were not significantly different between the Asian and European scenes.

Austrian Caucasian sample. The same AOIs and focal/nonfocal objects from the Malaysian Chinese sample were used.

Identical AOIs were drawn over on Adobe Illustrator. Each AOI was assigned an RGB grey value, thus resulting in a range of 1 to 211 for all AOIs across Asian and European scenes. This was used by a Matlab script to identify each AOI for extracting fixation number and duration.

4.3.1.2 AOI normalisation

The same AOI normalisation as described in Chapter 3 was used in this study.

4.3.1.3 Verbal descriptions

Malaysian Chinese sample. Due to each scene having different AOIs, two lists of all possible AOIs within Asian and European scenes were included in the coding form. The description component was further divided into *featural* and *configural* description types.

Scene coding rules were based on Masuda and Nisbett (2001), who divided the descriptive data into segments corresponding to the smallest linguistically meaningful element. Words related to the subject of the sentence were accumulated.

In the present study, featural descriptions were defined as 1) the mention of an object; 2) descriptions referring to an object's characteristics (size, colour, amount etc.); and 3) other descriptions specific to the object being described. For example, a "big, silver-coloured van" is coded as two featural descriptions under the "Van" AOI.

Configural descriptions were defined as: 1) general descriptions of the area (e.g. "this is an Asian/European city"; "this is a quiet part of town"); 2) the comparison of one feature to another or the relationship between features (e.g. "the red car is bigger than the blue car"; and 3) descriptions containing verbs of movement or the use of prepositions (e.g. "the van is moving towards the car"). Only the subject of the sentence appearing before the verb is coded. For a detailed table of the coding rules, see Appendix B.

Two coders who were fluent in Chinese and English, and blind to the hypotheses, were recruited to code the verbal descriptions. The raters listened to the recordings exported from Tobii Studio, and viewed the scene images, and recorded the frequency of featural and configural descriptions of each AOI onto the coding form.

On the coding form, featural and configural AOIs were then marked by the experimenter before the data was processed into the same four categories above. Data from both coders were calculated to obtain a Cronbach α for each rating category. The mean Cronbach α for Featural and Configural descriptions was 0.95 and 0.94 respectively, indicating high intercoder reliability. The two raters' mean ratings for each rating category (e.g. English/Asian scenes/Focal/Featural) were calculated and used in the final analysis.

Austrian Caucasian sample. The same street scene coding rules above were used. Two coders who were fluent in German and English, and blind to the hypotheses, were recruited to code the verbal descriptions. Coding was performed according to the same criteria and procedure as in Study 1.

Data from both coders were calculated to obtain a Cronbach α for each rating category. The mean Cronbach α for Local and Global description was 0.88 and 0.90 respectively, indicating high intercoder reliability.

The two raters' mean ratings for each rating category (e.g. English/Asian scenes/Focal/Featural) were calculated and used in the final analysis.

4.3.1.4 Eye-tracking

Malaysian Chinese sample. Initial data extraction occurred within Tobii Studio v3.0 software. The AOIs for each image were calculated and coded on Excel into four categories: focal/featural, focal/configural, nonfocal/featural, nonfocal/configural.

The Velocity-Threshold (I-VT) fixation filter from Tobii Studio detects the eyes' angular velocity (30°/second) and discards fixations that are less than 60ms (Olsen, 2012). Samples that are of the same or higher velocity of this threshold are classified as belonging to a saccade (Olsen, 2012). To ensure the validity of the eye-tracking data, a sampling percentage of 50% on Tobii Studio was used as a minimum for inclusion for data analysis.

Austrian Caucasian sample. Following the SR Research algorithm, fixations were defined as the average gaze position during periods when the change in recorded gaze position was smaller than 0.1°, eye movement velocity below 30°/s, and acceleration below 8000°/s^2, respectively. Fixations below 100ms and above 2000ms were excluded from the analysis.

4.3.1.5 Correlations between language fluency and eye-tracking variables

Correlations between verbal description frequencies and language fluency ratings were conducted to ascertain whether there is a direct correlation between language fluency and description frequencies. If fluency were to be driving the results, a correlation between language fluency and description fluency would be found.

For the Malaysian Chinese sample, no correlations were found between both language fluency variables and description frequency, all $p > 0.003$ (0.05/16 per test). For the Austrian Caucasian sample, all but one correlation between both language fluency variables and description frequency were nonsignificant, all $p > 0.003$ (0.05/16 per test). Only the correlation between English fluency and English/Asian/Focal/Featural was significant, $r(29) = 0.55$, $p = 0.002$.

Altogether, the correlation results indicate that fluency in one language had no effect on any measures when the participant was speaking in the other target language. Further, the correlations do not extend to looking strategies at non-focal AOIs. Thus language fluency was not included in the main analyses as a covariate. See Appendix D for correlation tables.

4.3.2 Eye-tracking

One participant was excluded from the eye tracking analysis due to poor sampling by the eye tracker (less than 50% of samples were captured), and one participant was excluded from the verbal descriptions analysis due to making no descriptions during the experiment.

4.3.2.1 Fixation Count

To test whether looking patterns on focal and nonfocal AOIs differed according to the language spoken, a 2 (language: English or Chinese/German) x 2 (location: Asian or European) x 2 (AOI type: focal or nonfocal) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged proportions of fixation count falling on focal and nonfocal AOIs for all participants. The data was normally distributed, all Shapiro-Wilk $p > 0.05$.

The two-way interaction for AOI and nationality was significant, $F(1, 55) = 17.08$, $p < 0.001$, $\eta_p^2 = 0.24$. An independent samples t-test showed that Malaysians looked more at focal AOIs than the Austrians did, $t(55) = 5.06$, $p < 0.001$. There was no significant difference between Malaysians and Austrians on the proportion of fixations on nonfocal AOIs, $t(55) = 1.56$, $p = 0.07$. This is further qualified by a three-way interaction for language, AOI type and nationality.

The three-way interaction for language, AOI type and nationality interaction was significant, $F(1, 55) = 4.69$, $p = 0.04$, $\eta_p^2 = 0.08$. To further elucidate this interaction, the data was split by nationality. A 2 (language) x 2 (feature) repeated-measures ANOVA was conducted on the split data.

The main effect for description type was significant in both the Malaysian and Austrian data, where there were significantly more proportions of fixation count on focal (*EMM* = 3.75, *SE* = 0.13 for Malaysians; *EMM* = 3.10, *SE* = 0.06 for Austrians) than nonfocal (*EMM* = 1.92, *SE* = 0.03 for Malaysians; *EMM* = 1.86, *SE* = 0.02 for Austrians) AOIs.

When split by nationality, the two-way interaction for language and AOI type was significant in the Malaysian data ($F(1, 21) = 7.15$, $p = 0.01$, $\eta_p^2 = 0.25$), but not in the Austrian data ($F(1, 34) = 0.14$, $p = 0.71$, $\eta_p^2 = 0.004$), in line with Hypothesis 2 that there will be no shifts in looking patterns when speaking English or German. Paired-samples t-tests show that Malaysians looked more frequently at nonfocal AOIs when speaking in Chinese than in English ($t(21) = 8.89$, $p < 0.001$, $d = 2.36$), supporting Hypothesis 1 that Malaysians will make more configural looking patterns when speaking in Chinese. No significant difference was found for focal AOIs when the Malaysian participants were speaking in Chinese or English, $t(21) = 0.73$, $p = 0.47$, $d = 0.20$). See Table 4.1 and Figure 4.2.

Table 4.1
Means and standard deviations for the Language and AOI Type interaction in the Malaysian data

	AOI type			
	Focal		Nonfocal	
Language	*M*	*SD*	*M*	*SD*
English	3.83	0.67	1.69	0.16
Chinese	3.67	0.91	2.14	0.21

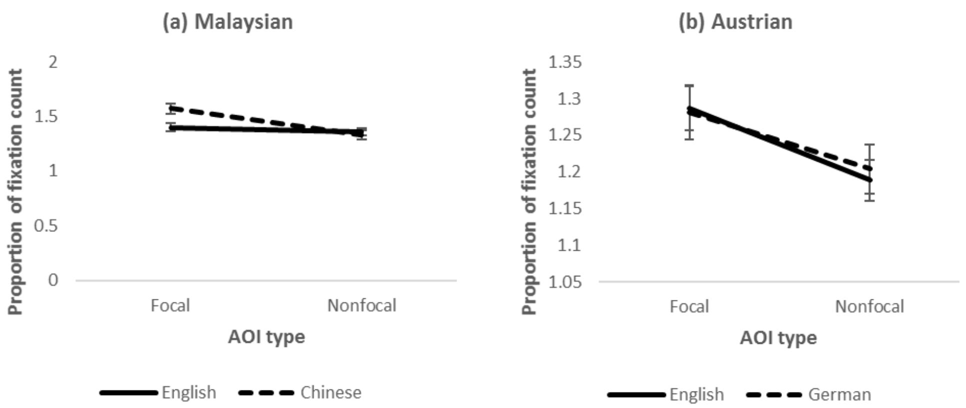


Figure 4.2 Proportions of fixation count for the Language, AOI type and Nationality interaction. Error bars depict standard errors of mean

The three-way interaction for AOI type, location and nationality was significant, $F(1, 55) = 11.40$, $p = 0.001$, $\eta_p^2 = 0.17$. Splitting by nationality, a 2 (AOI type) x 2 (location) repeated-measures ANOVA was conducted for Malaysian and Austrian participants.

The main effect for AOI type was significant in the Malaysian ($F(1, 21) = 167.01$, $p < 0.001$, $\eta_p^2 = 0.89$) and Austrian ($F(1, 34) = 316.64$, $p < 0.001$, $\eta_p^2 = 0.90$) data. Pairwise comparisons show significantly longer fixations on focal AOIs (*EMM* = 3.75, *SE* =0.13 for Malaysians; *EMM* = 3.10, *SE* = 0.06 for Austrians) than nonfocal AOIs (*EMM* = 1.92, *SE* = 0.03 for Malaysians; *EMM* = 1.86, *SE* = 0.02 for Austrians). The main effect for location was also significant in both the Malaysian ($F(1, 21) = 23.43$, $p < 0.001$, $\eta_p^2 = 0.53$) and Austrian ($F(1, 34) = 11.03$, $p = 0.002$, $\eta_p^2 = 0.25$) data. Pairwise comparisons show that participants made more fixations on Asian (*EMM* = 2.97, *SE* = 0.08 for Malaysians; *EMM* = 2.57, *SE* = 0.03 for Austrians) than European (*EMM* = 2.69, *SE* = 0.06 for Malaysians; *EMM* = 2.39, *SE* = 0.04 for Austrians) scenes.

The two-way interaction for AOI type and location was nonsignificant in the Malaysian data ($F(1, 21)$, 1.16, $p = 0.29$, $\eta_p^2 = 0.05$), but was significant in the Austrian ($F(1, 34) = 16.94$, $p < 0.001$, $\eta_p^2 = 0.33$) data. Paired-samples t-tests show that Austrians made more fixations on focal AOIs when looking at Asian scenes ($t(34) = 3.82$, $p = 0.001$, $d = 0.94$), and more fixations on nonfocal AOIs when looking at European scenes ($t(34) = 4.63$, $p < 0.001$, $d = 1.06$). Interestingly, in the Malaysian data, more fixations on nonfocal AOIs were found when participants were looking at Asian scenes ($M = 2.11$, $SD = 0.21$) than European scenes ($M = 1.72$, $SD = 0.25$), $t(21) = 5.10$, $p < 0.001$, $d = 1.67$. See Table 4.2

The results for the Austrian data are the opposite direction of Hypothesis 3 that more configural patterns on Asian scenes will be found, if looking and description patterns are determined by stimulus. Thus Hypothesis 3 is not supported. Although the interaction effect for AOI type and location was not found in the Malaysian data, t-test results support this hypothesis.

Table 4.2
Means and standard deviations for AOI type and Location in the Austrian data

	AOI type			
	Focal		Nonfocal	
Location	*M*	*SD*	*M*	*SD*
Asian	3.34	0.37	1.80	0.09
European	2.86	0.61	1.92	0.14

Other interactions were nonsignificant and irrelevant to our hypotheses, $p > 0.05$.

4.3.2.2 Fixation Duration

A 2 (language: English or Chinese) x 2 (location: Asian or European) x 2 (AOI type: focal or nonfocal) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged proportions of fixation duration falling on focal and nonfocal AOIs for all participants. The data was normally distributed, all Shapiro-Wilk $p > 0.05$.

The four-way interaction for language, AOI type, location and nationality was significant, $F(1, 55) = 36.54$, $p < 0.001$, $\eta_p^2 = 0.40$. To further elucidate this interaction, the data was split by nationality. The interaction for AOI and location was significant in the Austrian data, $F(1, 34) = 14.32$, $p = 0.001$, $\eta_p^2 = 0.30$; as expected, the three-way interaction for language, AOI type and location was nonsignificant, $F(1, 34) = 0.002$, $p = 0.97$, $\eta_p^2 < 0.001$. In the Malaysian data, the two-way interaction for AOI type and location ($F(1, 21) = 30.21$, $p < 0.001$, $\eta_p^2 = 0.59$) and the three-way interaction for language, AOI type and location were significant ($F(1, 21) = 30.12$, $p < 0.001$, $\eta_p^2 = 0.59$).

Paired-samples t-tests on the Austrian data using Bonferroni-adjusted *p* values of 0.025 (0.05/2) per test show longer proportions of fixation duration on focal AOIs when viewing Asian scenes ($t(34) = 3.39$, $p = 0.002$, $d = 0.82$) than European scenes, and longer proportions of fixation duration on nonfocal AOIs when viewing European scenes ($t(34) = 4.65$, $p < 0.001$, $d = 1.09$) than Asian scenes. These results are in the opposite direction of what was predicted in Hypothesis 3, thus this hypothesis is not supported. See Figure 4.3.

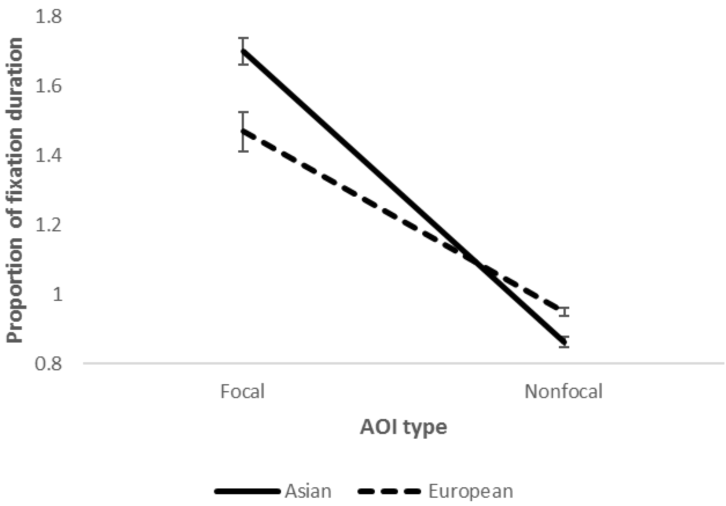


Figure 4.3 Proportions of fixation duration for the AOI type and Location interaction in the combined data. Error bars depict standard errors of mean.

Splitting the Malaysian data by language, two separate 2 (AOI type) by 2 (location) repeated-measures ANOVAs were conducted. In the English language condition, the two-way interaction for AOI and location was not significant, $F(1, 24) = 0.64$, $p = 0.80$, $\eta_p^2 = 0.003$. This interaction was significant in the Chinese-language condition, $F(1, 24) = 44.36$, $p < 0.001$, $\eta_p^2 = 0.67$. Paired samples-tests on the Chinese-language condition using Bonferroni-adjusted *p* values of 0.025 per test (0.05/2) show longer proportions of fixation duration on focal AOIs when viewing European scenes ($t(22) = 2.87$, $p = 0.009$, $d = 0.85$), but no significant differences between the proportions of fixation duration were found for nonfocal AOIs across Asian and European scenes when speaking in Chinese ($t(22) = 1.56$, $p = 0.13$, $d = 0.50$). See Figure 4.4.

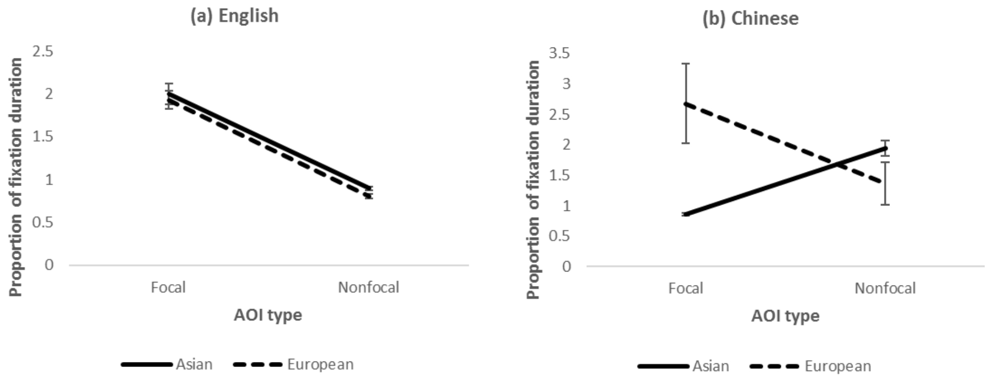


Figure 4.4 Proportions of fixation duration for Language, AOI Type and Location interaction: (a) Malaysian data (b) Austrian data. Error bars depict standard errors of mean.

The three-way interaction for AOI type, location and nationality was found in the combined data, $F(1, 55) = 64.86$, $p < 0.001$, $\eta_p^2 = 0.54$. Splitting by nationality, a 2 (AOI type) by 2 (location) repeated-measures ANOVA was conducted separately on the Malaysian and Austrian data. This interaction was significant in both the Malaysian ($F(1, 21) = 37.01$, $p < 0.001$, $\eta_p^2 = 0.64$) and Austrian ($F(1, 34) = 14.32$, $p = 0.001$, $\eta_p^2 = 0.30$) data.

In the Malaysian data, paired samples t-tests using Bonferroni-adjusted *p* values of 0.025 (0.05/2) show significantly longer fixations on focal AOIs when looking at European scenes ($t(21) = 2.69$, $p = 0.01$, $d = 0.80$) but no differences between the proportions of fixation duration on nonfocal AOIs were found when looking at Asian and European scenes ($t(21) = 1.65$, $p = 0.11$, $d = 0.54$). The main effect for AOI type (1, 21) = 31.51, $p < 0.001$, $\eta_p^2 = 0.60$) was significant. Pairwise comparisons show significantly longer fixations on focal AOIs (*EMM* = 3.73, *SE* = 0.34) than on nonfocal AOIs (*EMM* = 2.51, *SE* = 0.17). Here, Hypothesis 3 is partially supported.

In the Austrian data, paired samples t-tests using Bonferroni-adjusted *p* values of 0.025 (0.05/2) show significantly longer fixations on focal AOIs when looking at Asian scenes ($t(34) = 3.39$, $p = 0.002$, $d = 0.80$), and on nonfocal AOIs when looking at European scenes ($t(34) = 1.65$, $p < 0.001$, $d = 1.09$). The main effects for AOI type ($F(1, 34) = 257.04$, $p < 0.001$, $\eta_p^2 = 0.88$) and location ($F(1, 34) = 7.13$, $p = 0.01$, $\eta_p^2 = 0.17$) were significant. Pairwise comparisons show significantly longer fixations on focal AOIs (*EMM* = 3.17, *SE* = 0.07) than on nonfocal AOIs (*EMM* = 1.81, *SE* = 0.02), and longer fixations on Asian scenes (*EMM* = 2.57, *SE* = 0.03) than on European scenes (*EMM* = 2.42, *SE* = 0.05). Hypothesis 3 is not supported because the results are in the opposite direction to our predictions. See Table 4.3.

Table 4.3
Means and standard deviations for AOI Type and Location by Nationality

	AOI type			
	Focal		Nonfocal	
Location	*M*	*SD*	*M*	*SD*
Asian				
Malaysian	2.86	0.57	2.83	0.59
Austrian	3.40	0.46	1.73	0.17
European				
Malaysian	4.60	3.06	2.18	1.62
Austrian	2.94	0.68	1.90	0.15

4.3.2.3 Verbal Descriptions

Language, AOI type, nationality. To test whether the frequency of descriptions in English or Chinese/German differed according to focal or nonfocal AOIs, a 2 (language: English or Other Language [Chinese or German]) x 2 (AOI type: focal or nonfocal) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged frequency of descriptions for focal and nonfocal AOIs for all participants.

Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

A main effect of AOI type was found, $F(1, 53) = 193.17$, $p < 0.001$, $\eta_p^2 = 0.79$. Bonferroni-corrected pairwise comparisons show that Malaysian and Austrian participants described nonfocal AOIs (*EMM* = 45.27, *SE* = 1.56) more frequently than focal AOIs (*EMM* = 32.25, *SE* = 1.23).

Contrary to Hypotheses 1 and 2, the interaction effect for language, AOI type and nationality was nonsignificant, $F(1, 53) = 0.55$, $p = 0.46$, $\eta_p^2 = 0.01$) The interaction for language for AOI type was significant, $F(1, 53) = 4.39$, $p = 0.04$, $\eta_p^2 = 0.08$). Paired-samples t-tests using a Bonferroni-adjusted p value of 0.025 (0.05/2) showed more frequent descriptions of nonfocal AOIs than focal AOIs in Chinese/German than in English ($t(54) = 2.11$, $p = 0.04$, $d = 0.29$), though this difference becomes nonsignificant when Bonferroni correction is applied. No significant differences between the frequency of focal AOI descriptions in English or Chinese/German ($t(54) = 0.73$, $p = 0.47$, $d = 0.09$) were found. See Table 4.4 and Figure 4.5.

Table 4.4
Means and standard deviations for AOI type and Language

	Focal		Nonfocal	
	EN	CH/DE	EN	CH/DE
Means (SD)	32.55 (11.70)	31.58 (9.06)	43.27 (12.51)	47.13 (14.06)

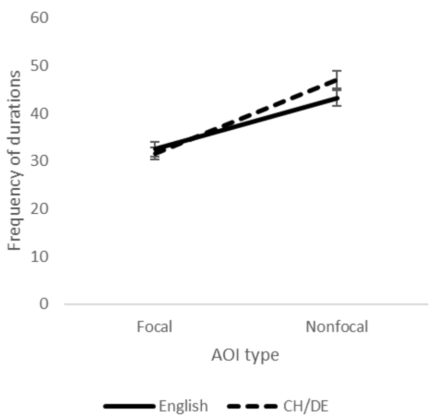


Figure 4.5 Frequency of descriptions for the Language and AOI Type interaction. Error bars depict standard errors of mean.

Language, description type and nationality. To test whether the frequency of descriptions in English or Chinese/German differed according to focal or nonfocal AOIs, a 2 (language: English or Other Language [Chinese or German]) x 2 (description type: featural or configural) x 2 (nationality: Malaysian or Austrian) mixed ANOVA was conducted on the averaged frequency of descriptions for featural and configural descriptions for all participants. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

There was a main effect of description type, $F(1, 53) = 427.99$, $p < 0.001$, $\eta_p^2 = 0.89$. Pairwise comparisons show more featural (*EMM* = 60.79, *SE* = 2.15) than configural descriptions (*EMM* = 16.73, *SE* = 1.09). The three-way interaction for language, description type and nationality was significant ($F(1, 53) = 6.64$, $p = 0.01$, $\eta_p^2 = 0.11$).

Splitting by nationality, a 2 (language) x 2 (description type) repeated-measures ANOVA was conducted. The two-way interaction was significant in the Austrian data ($F(1, 29) = 6.74$, $p = 0.015$, $\eta_p^2 = 0.19$) but not in the Malaysian data ($F(1, 24) = 1.24$, $p = 0.28$, $\eta_p^2 = 0.05$). There was a main effect for description type in both the Malaysian ($F(1, 24) = 131.06$, $p < 0.001$, $\eta_p^2 = 0.85$) and Austrian data ($F(1, 29) = 381.69$, $p <$

0.001, η_p^2 = 0.93). Pairwise comparisons show significantly more featural (*EMM* = 61.66, *SE* = 3.85) than configural (*EMM* = 18.62, *SE* = 1.97) descriptions in the Malaysian data, and also more featural (*EMM* = 59.93, S*E* = 2.25) than configural (*EMM* = 14.84, *SE* = 1.12) descriptions in the Austrian data . Paired-samples t-tests using Bonferroni-adjusted *p* values of 0.025 per test (0.05/2) on the Austrian data show more featural descriptions when speaking in German than when speaking in English, *t*(29) = 3.35, *p* = 0.002, *d* = 0.56. There was no significant difference in the frequency of configural descriptions when speaking in German or English, *t*(29) =1.02, *p* = 0.32, *d* = 0.15. See Figure 4.5. Hypothesis 1 and 2 are not supported.

Table 4.5
Means and standard deviation for Language and Description Type

	Featural		Configural	
	EN	DE	EN	DE
Means (SD)	56.05 (14.43)	63.80 (13.24)	14.33 (6.49)	15.35 (6.90)

AOI type and location. To test whether the frequency descriptions for focal and nonfocal AOIs differed according to location, a 2 (AOI type: focal or nonfocal) x 2 (location: Asian or European) repeated-measures ANOVA was conducted on the averaged frequency of descriptions. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

A main effect of location was found, *F*(1, 54) = 195,42, *p* < 0.001, η_p^2 = 0.78. Bonferroni-corrected pairwise comparisons show that European scenes (*EMM* = 45.21, *SE* = 1.54) were described more frequently than Asian scenes (*EMM* = 32.07, *SE* = 1.24). The interaction effect for AOI type and location was nonsignificant (*F*(1, 54) =

0.13, $p = 0.72$, $\eta_p^2 = 0.002$), failing to support Hypothesis 3, and suggesting that descriptions are not bound by stimulus type i.e. location.

Description type and location. The Malaysian Chinese and Austrian Caucasian description data was combined. To test whether the frequency descriptions for featural and configural descriptions differed according to location, a 2 (description type: featural or configural) x 2 (location: Asian or European) repeated-measures ANOVA was conducted on the averaged frequency of descriptions. Greenhouse-Geisser corrected values are reported whenever assumptions of sphericity were violated.

A main effect for description type was found, $F(1, 54) = 439.65$, $p < 0.001$, $\eta_p^2 = 0.89$. Bonferroni-corrected pairwise comparisons reveal more featural (*EMM* = 60.71, *SE* = 2.12) than configural descriptions (*EMM* = 16.56, *SE* = 1.10; mean difference = 44.16, $p < 0.001$). The interaction effect for description type and location was nonsignificant ($F(1, 54) = 2.95$, $p = 0.09$, $\eta_p^2 = 0.05$), failing to support Hypothesis 3, and suggesting that stimulus type i.e. location does not impact on description type.

4.4 Discussion

The present study found an effect of linguistic/cultural priming on the description and looking strategies of participants describing street scenes. In the Malaysian Chinese sample, we predicted that Malaysian Chinese participants would make more configural and less focal-object based looking and description patterns when speaking in Chinese, and more focal-object based looking patterns when speaking in English.

Overall, the Malaysian Chinese participants made more and longer fixations on focal objects than nonfocal objects in both conditions; however, they made more fixations on nonfocal objects when speaking Chinese than when speaking English, thus lending support to the Sapir-Whorf Hypothesis. When speaking in Chinese, participants looked longer at focal AOIs when viewing European scenes. Similarly, the Malaysian Chinese participants provided significantly more descriptions of focal objects than nonfocal objects.

In conclusion for the Malaysian data, these results lend some support to the Sapir-Whorf hypothesis. This will be discussed further in the General Discussion.

In the Austrian Caucasian sample, due to the individualistic nature of Germanic and Anglosphere cultures (Hofstede et al., 2010), we predicted no effect of linguistic/cultural priming on the bilingual Austrian Caucasian participants when speaking in English and German. This prediction was supported. Participants' looking strategy and description patterns did not differ according to the language condition. Participants did make more descriptions when speaking German than when speaking English, but this was probably because German is the participants' native language. It should be noted that, while the Malaysian participants showed similar proficiency in English and Chinese, the Austrian participants were native German speakers with a strong second language ability in English. This may explain why the Austrian participants made more descriptions in German than English, while the Malaysian participants did not differ in the number of descriptions made in English and Chinese.

We predicted Austrians would make more focal-object based looking and description patterns, and predicted more featural descriptions in both language conditions. While participants did make more featural descriptions, both fixations and descriptions were more frequently made of nonfocal objects, probably because they were more numerous than the focal objects in the stimuli.

Further, longer durations on focal AOIs in Asian scenes were found compared to European scenes, while longer durations on nonfocal AOIs were found in the

European scenes compared to the Asian scenes. These results support the idea that diagnostic details influence looking strategies. Miyamoto et al (2006) found that Japanese street scenes contained more contextual information and less differentiation between focal objects and background (more “ambiguous”) than American street scenes. This does not appear to be the case with the Asian and Western scenes used in the current study. Singapore is a newer and more modern city than Berlin, perhaps explaining this discrepancy.

Chapter 5
General Discussion

5.1 Overview of findings

This thesis aimed to investigate two explanations for the cross-cultural differences that have been observed in the way in which East Asian and White Caucasian participants recognise and describe faces. It was previously thought that the looking strategy used in face recognition tasks were universal, with participants looking in turn at the eyes and mouth (Janik et al., 1978). More recently, however, it was found that Mainland Chinese participants use a different strategy, fixating on the centre of the face (Blais et al., 2008; Jack et al., 2009). This has been interpreted as representing a more configural perceptual style in Asian participants, compared to a more featural style in Western participants. It has also been found that Asian participants who grew up in the West (Kelly et al., 2011), and Malaysian Chinese participants living in a highly multi-ethnic society (Tan et al., 2012) show intermediate looking strategies and a reduced own-race bias. These findings have led to two competing hypotheses about the causes of these cross-cultural differences in looking strategies. The first, the *cultural explanation* posits that these differences stem from wider cognitive differences associated with differences in culture – Asian participants from collectivistic societies process information, including faces, holistically, with more emphasis on the relationships between individuals, objects and ideas, while Western participants from individualistic societies process information, including faces, analytically, with more emphasis on the individuals, and individual facial features, themselves. The second hypothesis, the *facial information hypothesis* posits that these differing looking strategies stem from different diagnostic features in the faces in the visual environment during development. Thus, individuals growing up surrounded by Asian faces learn which processing style is most effective for distinguishing between Asian faces, and individuals growing up surrounded by Caucasian faces learn the processing style that best discriminates between Caucasian faces.

In this thesis, I have reported three studies aiming to address which of these hypotheses is more plausible. In Chapter 2, I report a study that attempted to link processing style to looking strategy in a face recognition task. We used Navon priming (Macrae & Lewis, 2002) to attempt to prime configural or featural processing in participants, and thereby affect the looking patterns, description patterns and recognition accuracy in a face recognition task. We found no impact of the Navon priming on the description pattern, recognition accuracy or looking patterns of the participants. However, we found that participants' looking and description patterns were substantially different from each other, suggesting that the way in which we describe faces may not match the way in which we actually recognise faces. We also noted that participants with stronger Asian accents made more configural descriptions than participants with more English accents.

In Chapter 3, therefore, we describe the results of a study that used a cultural/linguistic priming paradigm (Marian & Neisser, 2000; Hong et al., 2000; Pavlenko, 2003; Ross et al., 2002) to investigate the role of culture/language and facial appearance on the looking and description patterns of bilingual Malaysian Chinese and Austrian Caucasian participants. Again, we found substantial differences in the patterns of facial description compared to looking patterns, suggesting that participants describe faces in a way that is easy to express, rather than in a way that might be most advantageous for face recognition. We found that the Malaysian participants showed differences in description patterns when speaking Chinese (a language from a collectivist culture) compared to when speaking English (a language from an individualist culture). This effect was not seen in the Austrian Caucasian participants, who spoke English and German (both languages from individualist cultures). These results suggest that descriptions are influenced by language and/or culture, but only between two languages used to prime very different cultural backgrounds i.e. English (individualistic) and Chinese (collectivistic). For looking strategy, however, participants in both countries did not show significant differences in looking patterns depending on the race of the face being observed, suggesting that looking strategy may be impacted by the information in the faces, and supporting the facial information hypothesis.

Since there is strong evidence that faces are processed differently to other stimuli (Richler et al., 2009; Kanwisher et al., 1997), Chapter 4 presents the results of two studies that investigated the effects of cultural/linguistic priming on looking strategies and descriptions of street scene stimuli. A significant effect of cultural/linguistic priming was found for the eye movements and description patterns of Malaysian Chinese participants speaking English vs Chinese, but not for Austrian Caucasian participants speaking English vs German, suggesting that the cultural/linguistic prime was successful in causing cultural frame-switching in the Malaysian Chinese.

In this Chapter, I discuss these results in the context of the literature, as well as their implications and suggestions for future research.

5.1.1 Navon priming

In the Navon literature, studies have reported that priming participants with global or local Navon letters (Navon, 1977) enhances and impairs face recognition ability, respectively (Darling et al., 2009; Macrae & Lewis, 2002). For example, Macrae and Lewis (2002) asked participants to learn a series of faces. Participants then either completed a global Navon task, a local Navon task or a control task before completing the recognition phase. Participants who completed the global Navon task showed an enhancement to face recognition, and participants in the local group showed an impairment to face recognition, relative to the control group. They concluded that faces are more effectively recognised using global processing. Lewis, Mills, Hills and Weston (2009) extended this hypothesis, demonstrating that this effect may be attributable to the Transfer Inappropriate Processing Shift (Schooler, 2002). This hypothesis suggests that face recognition is enhanced when encoding and recognition take place in congruent processing styles (i.e. both phases take place in a global style or in a local style), but is impaired when encoding and recognition take place in incongruent processing styles (i.e. encoding is local and recognition global or vice versa). Lewis et al (2009) found that participants who completed congruous Navon tasks before the encoding phase as before the recognition phase showed improved face recognition, and those who completed incongruous Navon tasks before the encoding and recognition phases showed impaired face recognition.

Our results in Chapter 2, however, failed to show any effects of priming local/global processing with a Navon task on face recognition accuracy, looking strategy or description strategy in Malaysian Chinese participants. We suggest two possible explanations for why this may have occurred.

Firstly, Malaysian Chinese use an intermediate looking strategy (Tan et al., 2012), thereby activating both global and local processing mechanisms. It has been suggested that local and global processing styles do not form a continuum, but are instead two discrete cognitive mechanisms (Fink et al., 1997). In this case, the intermediate looking strategy exhibited by the Malaysian Chinese participants (Tan et al., 2012) may indicate that both global and local mechanisms are activated simultaneously by default. Indeed, Kelly et al. (2011) suggest that British-born Chinese participants fell into two distinct groups – one that depended primarily on the local processing mechanism typical of British and other White Caucasian participants, and another that depended primarily on the global processing mechanism typical of Chinese and other East Asian populations. However, a reanalysis of Kelly et al.'s (2011) data suggested that these participants were actually using an intermediate processing strategy (Tan et al., 2012), possibly indicating that both local and global mechanisms were activated simultaneously. If this were the case in our Malaysian Chinese participants, it may be that a Navon task, which in this framework would be seen as priming either global or local processing by activating the relevant mechanisms, may be expected to be ineffective in this population (since both mechanisms are already activated). This hypothesis is merely speculation at present, however, and should be tested in future research.

A second possible explanation is that the face description phase caused verbal overshadowing, impairing the recall of faces in the recognition phase. This is a phenomenon whereby making a detailed description of a face between the encoding and recognition phases impairs subsequent recognition, and is thought to occur because the act of describing faces causes a shift towards local processing, which is detrimental to face recognition (Dodson, Johnson and Schooler, 1997; Schooler & Engstler-Schooler, 1990). Some support may be seen for this hypothesis in the fact that the descriptions used by the participants were overwhelmingly featural, suggesting that the act of describing faces may indeed cause an activation of local processing. Inconsistent with this hypothesis, however, is the finding that our participants' looking strategies did not differ substantially from previous studies in which Malaysian Chinese participants performed a face recognition task without any verbal description component (Tan et al., 2012), and face recognition was still good, with 72.1% of participants correctly identifying the Asian pool player and 58.1% correctly identifying the Caucasian pool player from a lineup of 10 faces. Further, if the verbal overshadowing effect were fully explained by a shift in processing style, one would still expect to see a difference in recognition accuracy between the two Navon groups, since those in the global group would have their global processing at least partially restored by the Navon task, while those in the local group would have this shift to a local processing style elicited by the verbal descriptions exacerbated by the local Navon task. This suggests that the disruption to face recognition caused by verbal overshadowing may not be entirely attributable to a shift towards local processing, but rather attributable to some other effect. Further, the verbal overshadowing effect is generally found to be weaker and less reliable than the Navon priming effect, often being reported as small (Meissner & Brigham, 2001), absent or even reversed (Clare & Lewandowsky, 2004; Itoh, 2005; Lyle & Johnson, 2004), making it surprising that verbal overshadowing may eliminate the Navon priming effect.

Finally, it should be noted that there have been a number of previous failures to replicate the effect of a Navon task on face recognition. For example, Brand (2004) conducted two high-powered replication attempts, finding a significant result in only one of them. Lawson (2007) reports three failed replications, suggesting that the effect may not be as robust as reported in Macrae and Lewis (2002). Lawson also points out that that previous replications of the Navon priming effect have found substantially smaller effect sizes than those reported in Macrae and Lewis (2002), and suggests that multiple analyses of data, without correction, or selective reporting of results, may explain these previous successful replications. For example, Weston and Perfect (2005) found an effect of Navon priming on face recognition speed in the first four trials, but not on later trials or on recognition accuracy. The study reported in Chapter 2 therefore represents an additional failed replication, possibly suggesting that the Navon priming effect is easily disrupted by minor variations in methodology. It should, however, be noted that, given the relatively small effect sizes found in many of the replications of the original study (Lawson, 2007), our failure to replicate the original result may be attributable to our relatively small sample size.

5.1.2 Relationship between verbal descriptions and looking strategy

Another finding from Chapter 2 was that the pattern of features fixated on was not congruent with the pattern of features described by the participants. While the eyes were both fixated frequently and described frequently, and the mouth was both fixated and described relatively infrequently, the treatment of the nose and hair was substantially different across the two tasks. Along with the eyes, the hair was the most described feature. However, it was fixated upon less frequently than either the eyes or the nose. Conversely, along with the mouth, the nose was the least frequently described feature, yet it was the most frequently fixated feature along with the eyes.

It may be, therefore, that the factors determining the looking strategy and description patterns are different. Indeed, we find that, while the pattern of eye movements was different depending on the race of the faces observed, this effect of race was not observed for the descriptions. Participants fixated significantly more frequently, and a nonsignificant trend suggested for a longer duration, on Caucasian faces' hair than Asian hair, and fixated significantly more frequently and for longer on Asian eyes and nose than Caucasian eyes and nose. This suggests that participants are adapting their looking strategies depending on the features that are most salient in faces of a particular race. Caucasian hair may be more salient for face identification than

Asian hair, for example, because Caucasian hair varies in colour and texture, while Asian hair is uniformly straight and black. This is broadly in line with the findings of Shepherd and Deregowski (1981) who demonstrated that variation in hair explained a significantly greater proportion of the variance in Caucasian faces than for African faces (which are more variable in the appearance of the lower facial features). It is not known why this pattern did not also extend to the eyes, however, since Caucasian eyes are also more variable in colour than Asian eyes. It may be predicted that variation in eye and nose appearance explains a greater proportion of variance in Asian than Caucasian facial appearance.

Ellis et al. (1975) suggested that people describe the parts of the face that are most useful for facial identification. That the effect of race of face did not extend to facial descriptions, and that the pattern of features described was so markedly different to the pattern of features fixated upon suggests that this may not be the case, however. It may be, instead, that the features described are predefined by cultural or linguistic norms. While we hypothesised that participants would use more configural descriptions to describe Asian than Caucasian faces, support was not found for this hypothesis. Instead, participants used significantly more featural than configural descriptions for faces of both ethnicities. It should be noted, however, that the eye-tracking data was obtained from a series of 5 second presentations of facial images belonging to 10 Asian and 10 Caucasian men, whereas the description data was obtained from a single 60 second presentation each of one Asian and one Caucasian man, so data may not be directly comparable. Further, this study only examined Malaysian Chinese participants speaking English. It was decided, therefore, that Chapter 3 would further investigate this phenomenon in Malaysian Chinese and Austrian participants speaking English and Mandarin/German.

5.1.3 Linguistic/cultural priming on face processing

Studies have found differing looking strategies in East Asians, who fixate preferentially on the centre of the face, possibly indicating a more global processing style, and White Caucasians who tend to fixate primarily on the eyes and the mouth, possibly indicating a more local processing style (Blais et al., 2008; Jack et al., 2009). East Asian people brought up in Western countries (Kelly et al., 2011) and Malaysian Chinese people living in a highly multicultural society (Tan et al., 2012) show an intermediate looking strategy, with fixations falling primarily on the eyes and nose. We propose two competing hypotheses to explain this phenomenon: the *facial information hypothesis* proposed that individuals develop race-of-face-specific face recognition expertise, learning from the faces encountered during development which features are most effective for distinguishing between faces, and the *cultural explanation*, which posits that facial processing is performed in a similar way to other cognitive processing in the culture in which the individual develops. In Chapter 3, we developed a series of testable hypotheses that followed from these two explanations, and performed two studies that aimed to address these hypotheses.

We predicted that, if the *cultural explanation* was correct, that cultural and linguistic priming, which has been shown to induce cultural “frame shifting” in bilingual participants (Hong et al, 2000; Pavlenko, 2003), should induce significant changes in face processing, which could be detected through changes in looking patterns measured using an eye tracker, and through description patterns given of faces. Alternatively, if the *facial information hypothesis* was correct, participants would fixate upon, and describe, the facial features that are most effective at discriminating between individuals for each race of face.

In Chapter 3, we tested these two competing hypotheses by using a cultural/linguistic priming paradigm for a face perception and description task. Participants completed a task in which they observed and described 4 Asian and 4 Caucasian faces. Participants completed this task twice (with different faces) in both English and either Chinese (Malaysian participants) or German (Austrian participants), after completing a cultural priming task in each language. It was found that the looking pattern of the participants differed significantly according to the race of the faces being observed, but not according to the cultural/linguistic condition. This suggests that the looking strategy used was dependent on the salient diagnostic features of the faces, and not on the cultural "frame", thus supporting the *facial information hypothesis*.

These results are in line with previous studies showing different looking patterns for own- and other-race faces. For example, Wang, Xiao, Quinn, Hu, Qian, Fu et al. (2015) reported different patterns by mainland Chinese participants when looking at own- and other-race faces, consistent with the findings of Fu et al. (2012) and Hu et al. (2014). The Chinese participants in Wang et al (2015) fixated on Caucasian eyes for a greater proportion of time than on Asian eyes, but spent a greater proportion of time fixating on Asian noses than on Caucasian noses. Similarly, Fu et al. found the Chinese participants to fixate more on Asian noses and mouths, but fixate more on Caucasian eyes. Wang et al. also explained these differences along the lines of the differing facial features that may be deemed diagnostic for East Asian and White Caucasian own-race faces. Again, this hypothesis is supported by our data, with both Caucasian and Asian participants showing similar differences between the looking patterns used to recognise Asian and Caucasian faces. Both Austrian Caucasian and Malaysian Chinese participants fixated more, and for longer on Caucasian hair and eyes than on Asian hair and eyes (both of which are more variable in Caucasian than in Asian faces). This suggests that it is the diagnostic features of different ethnic faces that drives the differences. However, other studies have shown mixed results, with some studies showing significant differences in fixations on own- vs other-race faces (Goldinger, He & Papesh, 2009) and other not (Blais et al., 2008; Tan et al., 2012). Arizpe, Kravitz, Walsh, Yovel & Baker (2016) suggest that this may be due to differences in the techniques used to analyse eye movements.

Studies have found quantitative support for differences in facial features across ethnic groups (Fang, Clapham, & Chung, 2011; Le et al., 2002). Le et al. (2002) found systematic variation in East Asian and North American Caucasian facial morphology such as a wider intercanthal distance (distance between the medial corners of both eyes) in relation to a shorter palpebral fissure (the opening for the eyes between the eyelids), a much wider soft nose within wide facial contours, a smaller mouth width, and a lower face smaller than the forehead height in East Asian faces than the North American Caucasian faces. It is not known, however, whether the parts of the face with the greatest within-race variance differ between ethnic groups.

Interestingly, the looking pattern seen in Malaysians was similar to that of the Austrian sample, inconsistent with the results of Blais et al. (2008), Tan et al. (2012), as well as those reported in Chapter 2. This could have been an effect of trial duration, or a result of simultaneously looking and describing the stimuli. In previous studies, participants passively looked at faces for 5 seconds per trial (Blais et al., 2008; Tan et al., 2012). In this study, participants described the faces (presented for 60 seconds) simultaneously while looking at it. It should be noted that the description task with target faces presented for 60 seconds (as detailed in Chapter 2) also produced a similar looking pattern. It has previously been shown that verbally describing faces induces a shift to a more featural processing style (Schooler & Engstler-Schooler, 1990). The effect of trial duration on looking and description patterns, as well as the nature of the looking task, should be further investigated in future studies.

The looking strategy deployed by the Caucasian and Asian participants did not differ according to the language spoken. This suggests that any cultural frame shifting induced by the cultural/linguistic priming did not influence cognition to the extent that face processing (as measured by fixation strategy) was affected. This is not consistent with the *cultural explanation.*

Descriptions

While previous studies have not examined the effect of cultural and cognitive frame shifting on looking strategies in a face perception task, this effect has been observed in participants' verbal responses to non-face related questions (Hong et al., 2000; Marian & Kaushanskaya, 2007; Pavlenko, 2003). In the current study, we also assessed the role of language spoken on the descriptions made of Asian and Caucasian faces. The language spoken did influence the facial features described for the Malaysian participants, with participants describing the hair more frequently when speaking English, but describing the nose more frequently when speaking Chinese. This may be interpreted as supporting the *cultural explanation*, with participants' descriptions of faces changing in response to different cultural primes. However, we are hesitant to interpret the results this way for a number of reasons. First, any effects of the linguistic/cultural priming did not extend to the other measured cognitive domain (looking strategy), suggesting that any frame shifting effects were limited. Second, the frequency of featural vs configural descriptions was not affected by the priming condition, with participants making overwhelmingly featural descriptions in both languages. We suggest, instead, that the description pattern may be determined by the conventions of the language (Gelman & Tardif, 1998; Winawer et al., 2007), such as the extent of vocabulary in a language to describe certain features.

Of course, it is also possible that the linguistic conventions of describing faces in different languages have developed to best describe faces of the dominant ethnic group in the culture. This explanation is supported by our results, with participants making more descriptions of hair when speaking English (a language that evolved in a geographical region where hair colour and texture is highly variable) than when speaking Chinese (which evolved in a region where hair is near-universally black and straight).

It does not, however, appear that participants are adjusting their description patterns in response to different ethnicities of faces in the same way that they adjust their looking strategies. Neither Austrian nor Malaysian participants made significantly different patterns of descriptions of Asian, compared to Caucasian faces. For both races of face, the hair and eyes were described more frequently than the nose and the mouth, again potentially reflecting linguistic conventions.

No difference in description patterns was found for Austrian participants speaking English, compared to when they were speaking German, other than a slightly higher overall number of descriptions in the German condition. Again, this is consistent with both the *cultural explanation* and a linguistic constraints model, since English and German are similar, both linguistically, and as cultures.

The Sapir-Whorf hypothesis (which proposes that language influences aspects of cognitive processes), then, may be partially supported (see 5.1.5 for further discussion on the Sapir-Whorf Hypothesis). While Malaysian Chinese participants' description patterns differed according to the language spoken, no evidence of language affecting cognition was found in the eye tracking data, suggesting that, if language did indeed influence cognition, this influence does not extend to face recognition.

5.1.4 Linguistic/cultural priming on scene processing

Following our findings in Chapter 3, two comparison studies were conducted and detailed in Chapter 4. Again, we performed two studies that aimed to address the two competing hypotheses: the *visual information hypothesis* (analogous to the *facial information hypothesis*) and the *cultural explanation* using naturalistic street scene images.

Two distinct patterns were found in the face stimuli – one for the looking pattern, and one for the descriptions. While the looking pattern supports the facial information hypothesis, with observers adopting different looking patterns depending on the race of the face, the descriptions, on the other hand, lend some support to the cultural explanation hypothesis and the Sapir-Whorf Hypothesis, with descriptions differing depending on the language spoken (for Malaysian Chinese participants). However, the effect of linguistic/cultural priming was not as large as may be expected, as the Chinese-language priming condition did not prompt participants to describe facial features more configurally (e.g. symmetrical eyes, one side of the mouth smaller than the other) than featurally (e.g. big nose, small mouth). These results are inconsistent with previous studies reporting a cognitive “frame-switch” following linguistic/cultural priming (Hong et al., 2000; Pavlenko, 2003). These previous studies, however, have used non-face stimuli, such as culturally-significant icons (Hong et al., 2000) and videos depicting scenes of a man and a woman in Ithaca and Kiev (Pavlenko, 2003). It may be, then, that there is something particular about faces that is less susceptible to these cultural/linguistic priming effects. It is thought that face stimuli are processed using different channels in the brain to non-face stimuli (Richler et al, 2009), and it may be that these specialised face processing mechanisms are less susceptible to cultural/linguistic priming than the mechanisms used for non-face stimuli, such as street scenes. While faces are thought to be processed in a specialised area in the brain called the fusiform face area (FFA; Kanwisher et al., 1997), scenes have been found to activate another region of the brain, the parahippocampal place area (PPA) significantly more than other types of visual stimuli (Epstein, Smith, & Ward, 2009).

In Chapter 4, we presented the results of two studies that examined the effects of cultural/linguistic priming on looking patterns and descriptions of non-face stimuli – street scenes. We sought to determine whether the pattern of cultural/linguistic priming effects seen in face stimuli would be replicated in non-face scene stimuli. Participants completed a task using the same paradigm as with the face stimuli, in which they observed and described four Asian street scenes (from Singapore) and four European street scenes (from Berlin). Participants completed this task twice (with different scenes) in both English and either Chinese (Malaysian participants) or German (Austrian participants), after completing a cultural priming task in each language.

Previous studies have shown East Asians to be more susceptible to contextual information in a scene, showing a more holistic processing style, than White Caucasians who are thought to focus on salient features in a scene and use a more analytical processing style (Nisbett & Miyamoto, 2005). For instance, Ji et al. (2000) asked participants to complete a rod-and-frame task in which they were asked to determine if the rod was oriented in line with the square frame surrounding it. They found that East Asian participants were more dependent on the angle of the frame than White Caucasian participants. In a change blindness study, American participants were more sensitive to changes in foregrounded objects than Japanese participants, who in turn were more sensitive in the background (Masuda & Nisbett, 2005). Further, East Asians have produced cultural products (Wang et al., 2012) and expressed aesthetic preferences (Masuda et al., 2008) containing richer contextual information, compared to Western participants in these studies. Miyamoto et al. (2006) suggested that this greater dependence on contextual information could have arisen from the visual complexity and ambiguity typical of the local visual environment. Japanese street scenes were found to be more ambiguous and contain more objects than American scenes.

In Chapter 4, we found that Malaysian Chinese participants made significantly more descriptions of nonfocal objects when speaking Chinese, than when speaking English, in the European scene stimuli. This suggests that the cultural/linguistic priming paradigm did impact on description strategy in scene stimuli. Contrary to our predictions, however, the language spoken did not impact on description type (featural or configural) in the Malaysian Chinese participants. This is inconsistent with Masuda & Nisbett (2001) and Sendaki, Masuda and Ishii (2014). Masuda and Nisbett (2001) found that Japanese participants made more configural descriptions of items in animated vignettes of a fish tank than the American participants, who made significantly more featural descriptions. In a replication of Masuda and Nisbett's (2001) study, Sendaki et al. (2014) found a similar pattern in the descriptions. Following a priming task, Japanese participants looked more at the background and provided more descriptions of the background (thereby using more Asian-typical patterns), compared to the American participants who looked more at the focal fish and provided more featural descriptions (thereby using more Western-typical patterns). In the Austrian Caucasian participants, no effect of linguistic/cultural-priming or "frame-switching" was found, consistent with our prediction, as English and German originate from similar, Western, individualistic cultures.

These results suggest an effect of cultural “frame-switching” by linguistic/cultural priming between a Western-typical analytical processing style and an Eastern-typical holistic looking style.

We also found longer and more frequent fixations on focal objects when looking at European scenes when primed to speak in English than in Chinese, as well as longer and more frequent fixations on nonfocal objects when speaking in Chinese than in English, also when looking at the European scenes, in line with Chua et al. (2005) and Goh et al. (2009). Both studies found the Asian participants (Mainland Chinese in Chua et al. and Singaporean Chinese in Goh et al.) to make more fixations on the background than on focal objects when passively-viewing naturalistic photo stimuli with prominently foregrounded objects, than the American participants did. These changes in looking strategy between language conditions in the Malaysian Chinese participants suggest that the linguistic/cultural priming may have indeed induced a cultural frame-switching in the cognitive frameworks used to process the images.

In contrast to the results in Chapter 3, a shift in looking and description patterns was found, suggesting that scene stimuli are more sensitive to linguistic/cultural-priming than face stimuli, and that the Malaysian Chinese participants’ cognitive framework might have shifted between linguistic/cultural primes. This is in line with previous studies demonstrating cultural frame-switching in bilingual participants following linguistic/cultural priming (Marian & Kaushanskaya, 2007; Marian & Neisser, 2000; Pavlenko, 2003). These findings are also consistent with previous studies suggesting that faces and scenes are processed differently (Epstein et al., 2006; Nakamura et al., 2001; Tanaka & Farah, 1993).

However, it should be noted that only in the European scenes was the effect of "frame-switching" and support for the Sapir-Whorf Hypothesis apparent, both in the looking and description patterns. This is in contrast with Miyamoto et al.'s (2006) suggestion, i.e. Asian scenes are more ambiguous and contain more objects, hence resulting in a greater reliance on contextual information by Asians. We offer an alternate explanation that older cities such as Berlin and the Japanese cities used in Miyamoto et al (2006) consist of buildings that are more visually complex (Herzog & shier, 2000; Herzog et al, 2011) and backgrounds that contain more objects than newer cities like Singapore.

5.1.5 Sapir-Whorf Hypothesis

Studies have shown that bilinguals give different responses when primed in different languages, implying that there is a shift in cultural mindset. The "strong" version of the Sapir-Whorf hypothesis (Sapir, 1952) posits that an individual's native language determines their thought processes and worldview. For example, people have a different conception of time in Hopi (a Native American language). The strong version has, however, been strongly refuted (Pinker, 1994). The "weak" version suggests that language does not determine or constrain cognitive style, but can influence it in certain circumstances. For example, Mandarin and English speakers' conception of time (Boroditsky, 2001), and Russian and English speakers' sensitivity towards detecting light and dark shades of blue (Winawer et al., 2007). Thus, the results in Chapter 4, which suggest that cultural "frame shifting", induced by cultural/linguistic priming can influence the looking strategy and description strategy used to view street scenes, are in line with previous studies (Athanasopoulos et al., 2010; Thierry et al., 2009; Winawer et al., 2007) supporting the "weak" version of the hypothesis.

The findings from Chapters 3 and 4 tell us more about the extent of the Sapir-Whorf Hypothesis. While linguistic/cultural priming led to a frame-switch in the scene stimuli, there was no effect on the face stimuli. Support for the Sapir-Whorf Hypothesis is shown when Malaysian Chinese looked at and described the European scenes in the Chinese-language condition more, in line with previous studies using verbal tasks and non-face stimuli (Marian & Kaushanskaya, 2007; Pavlenko, 2003). These findings are also in line with previous studies that faces are processed using different neural networks than other stimuli (Kanwisher et al., 1997).

5.2 Implications

Few studies have examined verbal descriptions of faces, despite the ubiquity of facial descriptions in everyday life, literary works (da Soller, 2010), and eyewitness descriptions (Meissner & Brigham, 2001), and particularly less so in a cross-cultural, cross-linguistic context. This is the first study to further extend the literature to the role of language as a cultural prime in descriptions. Previous studies have shown differences between East Asians and White Caucasians' looking strategy on faces. However, it was not known if these differences (East Asians looking at the centre of the face and White Caucasians at the eyes and mouth) have arisen from pre-existing cognitive differences, or individuals adapting their looking strategy to features that are most useful for identification in their environment. In Chapters 2 and 3, we demonstrate that face descriptions are bound by linguistic constraints, though individuals still adapt their looking strategy to the faces in their environment, in line with previous studies (Kelly et al., 2010; Tan et al., 2012). The comparison to scene stimuli in Chapter 4 further demonstrates that looking strategy for faces, and to an extent description, are less susceptible to linguistic/cultural priming, and are indeed a special case in visual processing.

Previous studies have used linguistic/cultural primes using image stimuli (Hong et al., 2000; Marian & Kaushanskaya, 2007) and video stimuli (Pavlenko, 2003) to induce different responses in verbal descriptions. Here, we used a novel experimental paradigm to induce cultural frame-switching while comparing looking and description patterns. To our knowledge, this is the first that examines the role of linguistic/cultural priming to prime an individualistic vs. collectivistic mindset, while comparing looking and verbal description patterns, and to investigate reasons for the two distinct patterns. We demonstrate that looking strategy is also influenced by linguistic/cultural-priming in Chapter 4. While Chua et al. (2005) and Goh et al. (2009) have demonstrated cultural differences in looking strategy, there was no priming.

The results offer a different explanation to what was suggested by Miyamoto et al. (2006) that Asian scenes containing more information give rise to Japanese participants' increased attention to contextual information. If older cities are indeed richer in contextual information than newer cities, as suggested in Chapter 4, future studies should further examine what determines scene complexity and ambiguity, and the effect of these factors on viewers' attention vs. cultural background.

If people do indeed describe what is easier to describe, rather than what is most diagnostic for identifying faces, then improvements to verbal description should be sought. Fallshore and Schooler (1995) have previously showed that better descriptions enabled better recognition of other-race, but not own-race faces. While descriptions seem to be bound by linguistic constraints, or people describing what is easy to describe, it is worth investigating if eyewitness descriptions could be improved, for example, if participants are asked to describe faces as configurally as possible.

5.3 Limitations and future directions

As aforementioned in Chapters 3 and 4, it should be noted that the language profiles of the Austrian Caucasian and Malaysian Chinese participants were not directly equivalent. While the Malaysian Chinese participants were true bilinguals, being equally proficient in both English and Chinese, the Austrian Caucasian participants were native German speakers who were fluent in English as a second language. While we anticipate that this will not be of major concern to the validity of the findings, future studies should ideally have both sets of participants with more similar language profiles.

While a Tobii T60 was used in Malaysia, an EyeLink SR 1000 was used in Austria. Given the different sampling rates of both eye-tracking systems (60Hz by the Tobii T60 vs. 500Hz for binocular-tracking by the EyeLink, respectively), different definitions of fixations would have arisen, therefore only enabling subjective comparison between the Malaysian Chinese and Austrian Caucasian data.

The Malaysian Chinese data cannot be generalised to all Asian populations. Malaysians have been exposed to a multi-ethnic, multi-cultural environment. People from countries with a more homologous demographic may be more or less attuned to variations in faces and scenes. Likewise, the Austrian German data cannot be generalised to all Caucasian populations of European descent. More comparisons between English and other Western European samples (and languages) should be sought to further examine if linguistic/cultural-priming does not elicit cultural frame-switching in two languages originating from similarly individualistic cultures. It would be interesting to extend these findings to studies on the two other major ethnic groups in Malaysia, i.e. the Malays and Indians. It is possible that the native languages of individuals from these ethnic groups may yield different effects from the cultural priming, and improve our understanding of the extent of linguistic constraints on faces.

In particular, Tamil, the most common language spoken among Malaysian Indians is an Indo-European language. It would be interesting to extend the current study to other Asian samples with similarly collectivistic cultures and different linguistic origins. This has been rarely explored out of East Asian, and currently Southeast Asian people, even though all of Asia consists of collectivistic cultures (Triandis, 1993). This would help establish how linguistic/cultural priming can be used to induce cultural frame-switching across different types of stimuli. Parallel to the aim of comparing English to Chinese-speaking individuals (to examine whether a more collectivistic mindset is primed when people speak Chinese), it would be interesting to see if the same effect applies to bilingual Hindi- and English-speakers. Hindi originates from Sanskrit and is associated with the ancient Indus civilisation. The English language is also taught as a compulsory second language, following a longer period of British colonisation from 1757 to 1947, after the dominant language of the state and Hindi as a national language.

The description pattern resulting from the face study, as previously suggested in Chapter 3, could have been due to participants being limited to facial features on a typical face, i.e. the hair, eyes, nose and mouth regions. This, however, is speculation and should be ascertained in future studies.

We found different looking patterns when faces were presented for 5s (Chapter 2) compared to when presented for 60s (Chapter 3). At 60s, the Malaysian Chinese and Austrian Caucasian participants shared almost the same looking pattern i.e. looking at the eyes the most. Previous research has instead showed that White Caucasians typically fixated more on the eyes than the mouth. Whether the duration of the viewing task, or the nature of the task (e.g. passive viewing vs. simultaneously looking and describing), influenced these patterns should be examined in future studies.

Despite describing to a computer screen, it is possible that participants may have been assuming a cultural background (e.g. of someone familiar with Malaysian Chinese or Austrian culture) while describing, which in turn could have had an effect on participants' word choice and types of verbal descriptions provided. In relation to this, future studies could also make objective measurements of cultural references and the quality of verbal descriptions as an effect of the linguistic/cultural priming.

The studies presented in this thesis used naturalistic, unmanipulated static photographic stimuli (screenshots from Google StreetView), while previous studies such as Chua et al. (2005) and Goh et al. (2009) have mostly used manipulated static stimuli (e.g. prominent foregrounded objects against a backround). Participants were instructed to imagine describing the face and scenes to the police in as much detail as possible. Future studies using the same experimental paradigm could be extended to dynamic video stimuli (e.g. vignettes of everyday situations which require verbal description), as this may provide more realistic representations of description scenarios in real life, particularly in face stimuli because of the importance of faces in social situations.

5.4 Conclusion

Previous studies have found differences in how East Asians and White Caucasians look at faces (Blais et al., 2008; Jack et al., 2009). East Asians have been found to fixate more on the centre region of the face, while White Caucasians have tended to fixate more on salient features of the face (i.e. the eye and mouth regions). Malaysian Chinese, who live in a multicultural environment, as well as having been exposed to a significant Western influence in the media, have been found to use an intermediate strategy between the Asian- and Western-typical patterns, by looking more at the eyes and nose (Tan et al., 2012).

Previous studies have suggested two main explanations for these differences. The first is pre-existing cognitive differences between Asians, who use a holistic processing style (e.g. focussing on relationships between objects in a scene) and Westerners, who use an analytic processing style (e.g. focussing on salient objects in a scene) (Nisbett & Miyamoto, 2005). It is, on the other hand, also possible that individuals adapt their looking strategy to look more at the diagnostic cues for identifying faces in their environment. Ellis et al. (1975) suggested that White Caucasian and Black African participants described features according to what was useful for own-race faces, with the White Caucasian participants (who have more variances in hair and eye colour) describing faces more featurally and the Black African participants (who have dark-coloured hair and eyes) more configurally. The aim of this thesis, therefore, was to investigate whether the different looking strategies between how East Asians and White Caucasians look at faces were due to cultural differences or the facial appearance in the environment they are exposed to.

In Chapter 2, we found that Malaysian Chinese participants' looking strategy was influenced by facial appearance, but their verbal descriptions of the East Asian and White Caucasian faces appeared to be distinctly different, possibly because of constraints imposed by language. In Chapter 3, we attempted to use cultural priming to induce these cultural differences but again found that facial appearance influenced looking pattern and language influenced description patterns.

Linguistic/cultural priming has been found to induce collectivistic or individualist thinking in bilinguals (Hong et al., 2000; Marian & Kaushanskaya, 2007). In Chapter 4, our findings show support for linguistic/cultural-priming and the Sapir-Whorf Hypothesis in the scene stimuli, but not in the face stimuli, suggesting that looking patterns in face perception tasks are more susceptible to differences in facial appearance.

In conclusion then, we find that the looking patterns exhibited by participants observing faces is consistent with the facial appearance hypothesis, but not the cultural explanation, since looking patterns differed depending on the race of faces observed, but were unaffected by the cultural/linguistic prime. However, the description patterns showed evidence of being bound by language, differing based on the language spoken, but not based on the race of face described. Evidence from the scene task in Chapter 4 suggests that the linguistic/cultural priming used was successful, since it induced differences in looking strategy and description patterns in Malaysian, but not Austrian, participants.

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Appendix A

Nonparametric tests on description frequency

Feature

As data was not normally distributed in a few variables (Shapiro-Wilk tests $p < .05$), nonparametric tests were also conducted. A Friedman's ANOVA was conducted on the sums of the Hair, Eyes, Nose and Mouth for EA and WC descriptions. Description frequencies for the EA face differed significantly across features, X^2 (3) = 40.99, $p < .001$. Differences in description frequencies were also found in the WC face, X^2 (3) = 45.01, $p < 0.001$.

Wilcoxon signed-ranks tests, the nonparametric equivalent of paired-samples t-tests, were used to follow up this finding. A Bonferroni correction was applied, thus all effects are reported at a .025 level of significance. The sums of EA and WC Hair, Eyes, Nose and Mouth descriptions were compared feature by feature. No significant difference was found between EA and WC description frequencies for Hair, T = 156.00, r = -0.03, Eyes, T = 199.00, r = -0.06, Nose, T = 67.50, r = -0.12, or Mouth, T = 175.50, r = -0.05. These results suggest that Malaysian Chinese describe EA and WC features in a similar pattern.

As no significant difference was found between EA and WC description frequencies, the data was collapsed and compared together as Hair, Eyes, Nose and Mouth. A Friedman's ANOVA was conducted on these sums. Significant differences between the four features were found, X^2 (3) = 47.29, $p < .001$. A Wilcoxon signed-ranked test was conducted to compare the individual differences between Hair and Eyes, Eyes and Nose, and Nose and Mouth. No significant differences were found between description frequencies for Hair and Eyes, T = 265.50, $p > .05$, r = -0.04, and Nose and Mouth, T = 220.50, $p > .05$, r = -0.03. However, Eye descriptions were significantly more than Nose descriptions, T = 15.00, $p < .001$, r = -0.71., and mouth, T = 31.00, $p < .001$, r = -0.71, and Hair descriptions were significantly more frequent than nose $T = 20.00$, $p < .001$, $r = -0.72$, and mouth, $T = 54.50$, $p < .001$, $r = -.70$. See Figure A1.

In summary, both the repeated-measures ANOVA and nonparametric tests reveal that Malaysian Chinese participants provided significantly more descriptions of the hair and eyes, compared to descriptions of the nose and mouth. This pattern differs from participants' looking strategy as detailed in sections 4.1 and 4.2 of this chapter.

Further, no cross-cultural differences were found between descriptions of facial features, suggesting that Malaysian Chinese participants use similar methods of describing faces of these two ethnic groups.

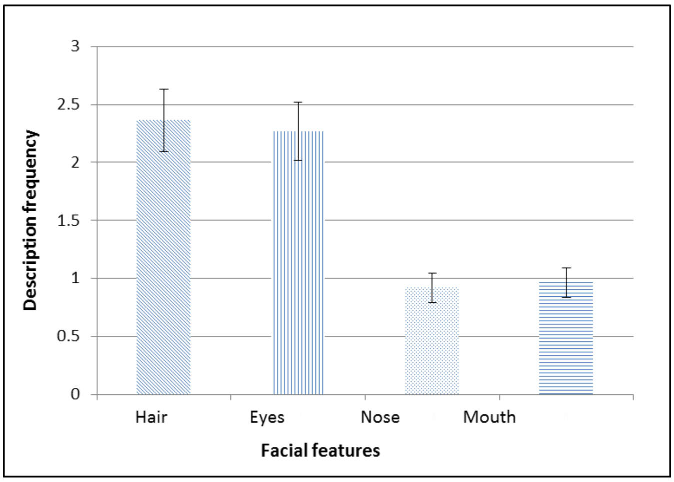

Figure A1. Means of description frequency on the hair, eyes, nose and mouth. Error bars report standard errors of the mean.

Description Type

As the data was not normally distributed in a few variables (Shapiro-Wilk tests $p > .05$), nonparametric tests were conducted. A Friedman's ANOVA was conducted on the sums of featural and configural descriptions for both EA and WC, X^2 (3) = 87.96, $p < .001$.

Two separate Wilcoxon signed-rank tests were conducted on the sums of EA and WC featural and configural description frequencies to follow up this finding. There was no significant difference between EA and WC featural and configural description frequencies, *T*

= 145.50, $p > .05$, $r = -0.20$ for Featural descriptions and $T = 82.50$, $p > .05$, $r = -0.19$ for Configural descriptions.

As no significant difference was found between the races of faces were found, the EA and WC description frequencies were collapsed and the total sum of all Featural and Configural descriptions was compared. Featural descriptions were given significantly more frequently than that of Configural descriptions, $T = 1.50$, $p < .001$, $r = -0.82$.

Appendix B

Rules for coding scene images

List of objects: Asian

	Featural
Building	Size; colour; height; length; name of building or signage; other descriptions specific to the building (e.g. architectural style)
Bus stop	Size; colour; amount of people
Camera shop	Size; colour; height; length; amount; name of building or signage
Car(s)	Size; colour; amount; car make or model; other descriptions specific to the car
Construction works	
Electric box	
Curb	
Grass	Size of grassy area
Hotel	Size; colour; height; length; name of hotel; other descriptions specific to the hotel (e.g. architectural style)
House	Size; colour; height; length; other descriptions specific to the house (e.g. architectural style)
Junction	
Lamp post	Height;
Lorry	Size; colour; amount; lorry make or model; other descriptions specific to the lorry
Pathway	
Pedestrian	Colour of clothes; gender; age; other physical characteristics
Railing	Colour; length; design/pattern
Road	Size; width
Shops	Size; colour; height; length; name of shop or signage; other descriptions specific to the shop (e.g. architectural style)
Sidewalk	
Signboard	Size; colour; content
Stop sign	
Temple	
Traffic light	
Tree(s)	Size; amount; type of tree
Row of trees	
Van	Size; colour; amount; van make or model; other descriptions specific to van
Walkway	
Wall	Colour; length; height
Whole scene	

List of objects: European

	Featural
Bicycle lane	
Bicyclist	Colour of clothes; gender; age; other physical characteristics
Biker	Colour of clothes; gender; age; other physical characteristics
Building	Size; colour; height; length; name of building or signage; other descriptions specific to the building (e.g. architectural style)
Café	Size; colour; name; amount of customers; other descriptions specific to the café
Car	Size; colour; amount; car make or model; other descriptions specific to the car
Row of cars	
Church	Size; colour; height; length; name of building or signage; other descriptions specific to the building (e.g. architectural style)
Hotel	Size; colour; height; length; name of hotel; other descriptions specific to the hotel (e.g. architectural style)
Hotel-side door	
Parking	
Petrol station	
Pedestrian(s)	Colour of clothes; gender; age; other physical characteristics
Restaurant	Size; colour; amount of customers; other descriptions specific to the café
Road	Size; width
Rubbish bin	
Rubbish dump	
Side door	
Sidewalk	
Street limit sign	
Tram	
Tram lines	
Tram tracks	
Tree	Size; amount; type of tree
Tree trunk	
Upstairs / Downstairs	
Van	Size; colour; amount; van make or model; other descriptions specific to the van
Whole scene	

General rules

Featural:
Mention of object
Description referring to a specific object's properties
- Size; colour; height; length; amount; other descriptions specific to the object being described

Examples:
"There is a car, a van, some trees…" – car/featural x1, van/featural x1, trees/featural x1 etc.
"Big, silver van" – van/featural x 2
"Lorry with red sign and Chinese characters" – lorry/featural x 2
"Hotel with three storeys" – hotel/featural x 1
"Many people at the bus stop" – bus stop/featural x 1

Configural:
Description of the area in general
- Business district; Asian/European city; quiet/busy part of town; weather…

Comparison to other features; relationships between features; verbs of movement
- When two or more objects are compared or mentioned*
- Indication of movement/ use of prepositions**

Examples:
* "The car on the left is **bigger than** the car on the right" – Car-1/configural x1, Car-2 configural x1
** "The van is **moving towards** the car" – Van/configural x1 (because the van is the subject in this sentence)
"There is a car parked **in front of** the building" – Car/configural x1 (because the car is the subject in this sentence)

"The van is moving towards the car"
(Subject) (verb) (direct object)

When featural *and* configural descriptions are combined in one sentence:
"The red car is **next to** the blue car" – red: Car/featural x1, blue: Car/featural x1, **next to:** Car/configural x1 ~~2~~
"There is a silver van parked **in front of** the big hotel" – silver: Van/featural x1, big: Hotel/featural x1, **in front of**: Van/configural x1, ~~Hotel/configural x1~~

NB.

1. Code repetitive descriptions separately
2. Code only descriptions that fall within the AOI regions
3. Idiomatic expressions / cultural references / personal attributes
4. Note down first three descriptions

Appendix C

Language history questionnaire

Language Background

1. Date of birth (DD/MM/YYYY) : ______________

2. Gender : Male / Female

3. Nationality : __________________

4. Region/State/City do you originate from (e.g. Kuala Lumpur) : __________________________________

5. Course & Student ID : __________________________________

   :Pre-sessional / Undergraduate / Postgraduate

6. Year of study : Not Applicable / 1^{st} / 2^{nd} / 3^{rd} / 4^{th}

7. First/Native Language (including dialects e.g., Hokkien, Hakka, telugu)

   :___________________________________

8. What language(s) does your Mother speak? :___________________________________

9. What language(s) does your Father speak? :___________________________________

10. List all the languages you know (including dialects e.g., Hokkien, Hakka, telugu) in order of most proficient. Rate your ability on the following aspects in each language. Please rate according to the following scale (write down the number in the table):
    1- Very poor
    2- Poor
    3- Fair
    4- Functional
    5- Good
    6- Very good
    7- Native-like

Language	Reading	Writing	Speaking	Listening

	Proficiency	Proficiency	Fluency	Ability/Comprehension

11. Provide the age at which you were first exposed to each language (including dialects e.g., Hokkien, Hakka, telugu) in terms of speaking, reading and writing, where you have learnt them from and the number of years you have spent on learning each language.

Language	**Age first exposed to the language**			**Where/ how was the language learnt?**	**Number of years learning**
	Speaking	Reading	Writing		

12. Please could you provide us with your Education Background:

Education Background			
School Level	Name of School	Languages taught	Main medium (Language) used for instructions
Kindergarden			
Primary School			
Secondary School			
College			
University			

13. Estimate, in terms of hours per day and percentage of daily life, how often you use your native language (first language) and other language per day for work or study related activities (eg. Going to classes, writing papers, talking to colleagues, classmates, or peers).

Language	**When do you use this language? (can be more than one)**	**Approximate Hours Spent per Day (hrs)**	**Percentage Estimated (%)**

14. Please could you provide us with your information about your English Proficiency qualifications (e.g. GSCE / SPM / IELTS / TOEFL):

Name of Test	Testing Date (mm/yyyy)	Overall Score/ Grade	Listening Score	Speaking Score	Writing Score
e.g. IELTS	09/2009	62	75	58	61

15. In which language (among your best two languages) do you feel you usually do better? Write the name of the language under each condition:

	At Home	**At Work/ Study**
Reading		
Writing		
Speaking		
Understanding		

16. Do / did you have any reading difficulties in your native language or other languages (e.g. dyslexia - a disorder that involves difficulty in learning to read or interpret words, letters, and other language symbols)?

Yes / No

If Yes, Please provide details:

____

____

17. Do you have any listening difficulties in your native or other languages (e.g. unable to accurately perceive/process, understand and respond to sound)? Yes / No

If Yes, Please provide details:

____

____

18. Do you have normal vision? (If you wear spectacles or contact lenses, you are not considered to have normal vision, but are corrected to normal vision.) Yes / No

If No, Please provide details:

____

____

Thank You ☺

Appendix D

Correlation tables

Correlations between language fluency variables and frequency of verbal descriptions (faces)

Malaysian Chinese sample

		EN_fluency	OT_fluency	Mean_EN_ EA_HairLocal	Mean_EN_ EA_Hair Global	Mean_EN_ EA_EyeLocal	Mean_EN_ EA_EyeGlobal	Mean_EN_ EA_Nose Local	Mean_EN_ EA_Nose Global	Mean_EN_ EA_Mouth Local	Mean_EN_ EA_Mouth Global	Mean_EN_ WC_Hair Local	Mean_EN_ WC_Hair Global	Mean_EN_ WC_EyeLocal	Mean_EN_ WC_Eye Global	Mean_EN_ WC_Nose Local	Mean_EN_ WC_Nose Global	Mean_EN_ WC_Mouth Local
EN_fluency	Pearson Correlation	1	.047	-.063	.327	.479**	.468**	.228	.179	.426*	.261	.008	.297	.417*	.457*	-.019	-.138	.140
	Sig. (2-tailed)		.804	.739	.077	.007	.009	.226	.344	.019	.163	.968	.111	.022	.011	.922	.468	.462
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
OT_fluency	Pearson Correlation	.047	1	.217	-.129	-.039	-.201	-.051	-.107	.135	-.109	.103	.173	-.007	.008	.040	-.006	-.017
	Sig. (2-tailed)	.804		.250	.498	.838	.286	.790	.574	.476	.566	.587	.361	.972	.968	.833	.975	.930
	N	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Continued from above:

Mean_CH_ EA_HairLocal	Mean_CH_ EA_Hair Global	Mean_CH_ EA_EyeLocal	Mean_CH_ EA_EyeGlobal	Mean_CH_ EA_Nose Local	Mean_CH_ EA_Nose Global	Mean_CH_ EA_Mouth Local	Mean_CH_ EA_Mouth Global	Mean_CH_ WC_Hair Local	Mean_CH_ WC_Hair Global	Mean_CH_ WC_EyeLocal	Mean_CH_ WC_Eye Global	Mean_CH_ WC_Nose Local	Mean_CH_ WC_Nose Global	Mean_CH_ WC_Mouth Local	Mean_CH_ WC_Mouth Global
-.040	.232	.179	.325	.128	.011	.290	.150	.050	.018	.193	.295	-.013	.055	.236	.279
.835	.217	.344	.080	.502	.953	.120	.429	.794	.926	.308	.113	.947	.774	.209	.136
30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
.345	.113	.260	.000	.136	.099	.185	-.221	.299	.028	.330	.194	.082	.137	.079	-.044
.062	.551	.165	.997	.474	.602	.328	.241	.109	.884	.075	.303	.668	.470	.679	.817
30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30

Austrian Caucasian sample

Correlations[b]

		EN_fluency	OT_fluency	Mean_EN_ EA_HairLocal	Mean_EN_ EA_Hair Global	Mean_EN_ EA_EyeLocal	Mean_EN_ EA_EyeGlobal	Mean_EN_ EA_Nose Local	Mean_EN_ EA_Nose Global	Mean_EN_ EA_Mouth Local	Mean_EN_ EA_Mouth Global	Mean_EN_ WC_Hair Local	Mean_EN_ WC_Hair Global	Mean_EN_ WC_EyeLocal	Mean_EN_ WC_Eye Global	Mean_EN_ WC_Nose Local	Mean_EN_ WC_Nose Global	Mean_EN_ WC_Mouth Local	Mean_EN_ WC_Mouth Global
EN_fluency	Pearson Correlation	1	.[a]	-.238	-.409	-.020	-.027	-.068	-.016	-.155	.171	.078	-.203	-.029	.306	.100	.158	-.228	.159
	Sig. (2-tailed)		.	.274	.052	.927	.901	.760	.943	.481	.437	.724	.353	.896	.155	.648	.472	.296	.469
	N	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
OT_fluency	Pearson Correlation	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]
	Sig. (2-tailed)	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23

Continued from above:

Mean_CH_ EA_HairLocal	Mean_CH_ EA_Hair Global	Mean_CH_ EA_EyeLocal	Mean_CH_ EA_EyeGlobal	Mean_CH_ EA_Nose Local	Mean_CH_ EA_Nose Global	Mean_CH_ EA_Mouth Local	Mean_CH_ EA_Mouth Global	Mean_CH_ WC_Hair Local	Mean_CH_ WC_Hair Global	Mean_CH_ WC_EyeLocal	Mean_CH_ WC_Eye Global	Mean_CH_ WC_Nose Local	Mean_CH_ WC_Nose Global	Mean_CH_ WC_Mouth Local	Mean_CH_ WC_Mouth Global
-.021	-.126	-.029	-.366	-.167	.017	-.067	-.042	.086	-.026	-.366	-.065	-.118	.059	-.209	-.284
.924	.567	.894	.085	.447	.937	.760	.848	.697	.908	.086	.768	.592	.790	.339	.188
23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]	.[a]
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23

Correlations between language fluency variables and frequency of verbal descriptions (scenes)

Malaysian Chinese sample

		EN_proficiency	OT_proficiency	EN_Asian_Focal_Featural	EN_Asian_Focal_Configural	EN_Asian_Nonfocal_Featural	EN_Asian_Nonfocal_Configural	EN_European_Focal_Featural	EN_European_Focal_Configural	EN_European_Nonfocal_Featural	EN_European_Nonfocal_Configural	DE_Asian_Focal_Featural	DE_Asian_Focal_Configural	DE_Asian_Nonfocal_Featural	DE_Asian_Nonfocal_Configural	DE_European_Focal_Featural	DE_European_Focal_Configural	DE_European_Nonfocal_Featural	DE_European_Nonfocal_Configural
EN_fluency	Pearson Correlation	1	0.204225	0.058177	0.193921	0.036919	-0.01482	0.129963	0.053978	0.052637	-0.2186	0.014358	-0.04931	0.498443	0.037249	0.074817	-0.15037	0.283262	0.04888
	Sig. (2-tailed)		0.401663	0.818638	0.440687	0.884364	0.953466	0.607258	0.831542	0.835672	0.383507	0.954908	0.845951	0.035257	0.88334	0.767958	0.551457	0.254693	0.847267
	N	19	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
CH_fluency	Pearson Correlation	0.204225	1	-0.122	-0.28252	0.290218	-0.17696	0.068017	-0.16086	0.219242	-0.16835	0.019975	-0.04551	0.197891	-0.1591	-0.15888	-0.47865	0.194358	-0.42028
	Sig. (2-tailed)	0.401663		0.629622	0.255996	0.242704	0.482386	0.788571	0.52369	0.382069	0.504296	0.937295	0.857679	0.431201	0.52831	0.5289	0.044485	0.439638	0.082468
	N	19	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Austrian Caucasian sample

		EN_proficiency	OT_proficiency	EN_Asian_Focal_Featural	EN_Asian_Focal_Configural	EN_Asian_Nonfocal_Featural	EN_Asian_Nonfocal_Configural	EN_European_Focal_Featural	EN_European_Focal_Configural	EN_European_Nonfocal_Featural	EN_European_Nonfocal_Configural	DE_Asian_Focal_Featural	DE_Asian_Focal_Configural	DE_Asian_Nonfocal_Featural	DE_Asian_Nonfocal_Configural	DE_European_Focal_Featural	DE_European_Focal_Configural	DE_European_Nonfocal_Featural	DE_European_Nonfocal_Configural
EN_fluency	Pearson Correlation	1	.a	.552**	0.359	0.26	0.209	0.265	0.238	0.227	0.299	0.063	-0.176	0.211	-0.083	0.024	-0.066	0.217	-0.181
	Sig. (2-tailed)		.	0.002	0.056	0.173	0.276	0.165	0.213	0.237	0.115	0.751	0.371	0.28	0.673	0.902	0.729	0.25	0.339
	N	34	34	29	29	29	29	29	29	29	29	28	28	28	28	30	30	30	30
OT_fluency	Pearson Correlation	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a
	Sig. (2-tailed)	.		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	N	34	34	29	29	29	29	29	29	29	29	28	28	28	28	30	30	30	30