An investigation of the modulation and underlying mechanisms of the self bias effect



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Thesis submitted for the degree of Doctor of Philosophy in Experimental Psychology

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The self bias effect refers to the prioritised processing of self-related information (i.e. faster RTs and higher accuracy) over information about others. This phenomenon has been widely observed across many areas of cognition such as memory, attention and perception. However, current knowledge of the self bias effect is still insufficient. This thesis utilises the perceptual matching paradigm as an experimental instrument to study the self bias effect in three main aspects.

First, the impact of social experiences on self bias is examined. This thesis presents data that demonstrate the modulation of self bias as a result of three factors – cultural background, situational cues and major life developments. Comparisons of the self bias between independent and interdependent cultures reveal a difference in the self bias relative to strangers. Priming of interdependent frames of mind reduces the self bias relative to friend in people with low bias, which suggests individual differences in the magnitude of the self bias effect. The transition into motherhood, as a major life development, demonstrates a loss of the self bias effect due to maternal behaviour.

Second, in the attempt to explain the robustness of the self bias effect, this thesis investigates the underlying mechanisms of self bias through parallel comparisons of self-related and reward-related stimuli using the perceptual matching task. To further explain the relationship between self and reward processes, electrophysiological responses are also examined with electroencephalogram (EEG) methods. The data demonstrate partial distinctions in the neural pathway that underlie self and reward processes.

Third, social psychology methods, in addition to methods from experimental psychology, are used to study the self bias effect from another perspective. However, the data are unable to link the self bias effect with trait characteristics at this stage.

This thesis contributes to current understanding of self-related processing by identifying the factors that modulate self bias and exploring the underlying mechanisms of self bias.

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Chapter 1

General Introduction

Self-related information is processed with greater priority in many aspects of cognition, this is referred to as the self bias effect. This thesis aims to explore the social factors, such as cultural experiences and important life developments, that modulate the self bias effect in perceptual matching. This thesis also examines the mechanisms underlying the self bias effect and its relationship with reward processing. Both experimental and social psychology methods are used to examine the self bias effect. First, this section introduces the background and previous research on self-related processing and the self bias effect, which lays a theoretical base for the thesis to discuss the modulation and mechanisms of the self bias effect. Then, the research goals and the research methods used in this thesis are discussed. Lastly, the structure of the thesis is briefly summarised.

1.1. The self bias effect

1.1.1. General background and previous research

Self-related information has long been observed to attract more attention than other information (e.g. Alexopoulos, Muller, Ric, & Marendaz, 2012; Bargh, 1982). More often than not, it is also processed with faster reaction times and greater accuracy. The enhanced processing of self-related information can be explained as having an evolutionary purpose. Prioritisation of self-related stimuli can enhance the adaptive-fitness of the self when encountering new stimuli or novel situations (Sedikides & Skowronski, 1997). In other words, the ability to identify and prioritise self-related information can maximise personal goals to enhance individual survival and facilitate the decision-making process. The development of automatic and improved perceptual capacities is also important to allow rapid mental registration of an accurate account of the stimuli (Kaplan & Kaplan, 1978). This is crucial because new stimuli that do not fit

into pre-existing conceptual categories can hinder rapid response. Consequently, faster responses to highly self-relevant stimuli and the improved perceptual capacity for novel stimuli are essential to survive in novel environments. This means that the bias toward self-related processing is plausibly an instinct embedded through evolution.

This prioritisation of self-related information processing, or the self bias effect, has been found in many cognitive studies. For instance, dichotic listening studies that presented different messages to each ear while asking the participant to pay attention to only one ear found that people were able to report instances of self-name presented in the ignored ear, even when completely oblivious to other information presented in that same ear (Cherry, 1953; Moray, 1959).

Studies on memory have also found that information encoded in self-reference has a significant advantage over information encoded in reference to others (Symon & Johnson, 1997). For example, it was found that recognition of adjectives was better if the words were encoded with a self-related cue question ("Describe you?") than words encoded with cue questions on the structure ("Big letters?"), semantics ("Means the same as xxx?"), or phonetics ("Rhymes with xxx?") (Rogers, Kuiper, & Kirker, 1977). Even assumed ownership of objects improves memory recognition. In one study, participants either moved or observed the movement of cards into two baskets – one basket belonged to the participant, the other to someone else (Cunningham, Turk, Macdonal, & Macrae, 2008). Recognition for self-owned items was significantly better and faster in speed than for items owned by the other person (Cunningham, Turk, Macdonal, & Macrae, 2008). In a similar study, Turk and colleagues (2011) presented images of objects (e.g. apple, socks) followed by a coloured border around the image that indicated whether the object belonged to the participant or the experimenter. Ownership of objects resulted in increased attentional processing as demonstrated by

increased P300 amplitudes in contrast to objects owned by the experimenter (Turk et al., 2011). This self bias effect is quite robust and have been consistently observed in other studies (e.g. Hamami, Serbun, & Gutchess, 2011; Serbun, Shih, Gutchess, 2011).

Facial recognition tasks also demonstrated the self-bias effect. Faces that belonged to the self, a familiar other and an unfamiliar other were presented on screen in different orientations. Participants were asked to identify the orientation of the faces irrespective of the person the face belonged to. The RTs for the self faces were significantly faster than for the familiar and unfamiliar faces (Ma & Han, 2010; Sui, Zhu, & Han, 2006). Face identification tasks, where the screen either displayed one face at a time (Keenan et al., 1999) or multiple faces in a circle around the fixation cross (Tong & Nakayama, 1999), consisted of self faces and stranger faces also showed faster RTs in identifying the self face than faces of others (Keenan et al., 1999; Tong & Nakayama, 1999). Keyes, Brady, Reilly, and Foxe (2010) examined face processing using EEG. Participants were asked to view images (faces of self, friend, stranger and images of flowers) and monitor for infrequently occurring repetitions. Faces of the self resulted in reduced peak amplitudes in the P2 (located in the posterior region) and N2 (located in the fronto-central region) components than friend or stranger faces. This reflects a differentiation in the electrophysiological responses between self and non-self stimuli (Geng, Zhang, Li, Tao, & Xu, 2012).

Functional magnetic resonance imaging (fMRI) studies also support differential processes for self and non-self stimuli. Self-related processing activates particular regions of the brain, such as the medial prefrontal cortex, in comparison to non-self stimuli (Fossati et al., 2004; Gusnard et al., 2001; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Ng, Han, Mao & Lai, 2010; Northoff et al., 2006; Ruby & Decety, 2004). For example, Kelley and colleagues (2002) examined self-referential

processing through fMRI. Judgements on trait adjectives in reference to the self ("Does this adjective describe you?") demonstrated greater activation in the medial prefrontal cortex and the posterior cingulate in contrast to other-reference judgments ("Does this adjective describe current US president?"). Another fMRI study also showed that the right hemisphere of the brain, especially the inferior frontal gyrus, was found to show increased activation in response to self-voice and self-face stimuli than non-self stimuli (Kaplan et al., 2008). This suggests a hemispheric lateralisation of self-processing in the brain.

1.1.2. Modulation of the self bias effect

Although self-related processing has consistently demonstrated a cognitive bias in performance, exceptions have been observed whereby the magnitude of the self bias effect was weakened against other stimuli. For instance, in a study where participants viewed pictures of faces that belonged to the self, friend and a stranger, recognition of the self face was much faster and more accurate than recognition of friend and stranger faces. However, recognition of friend face was faster than stranger face when the faces were presented upright. This resulted in a smaller response differences between self and friend faces than between self and stranger faces (Keyes & Brady, 2010), which suggests that the self bias effect can be modulated. Thus, the following sections will introduce social factors that could modulate the self bias effect.

1.1.2.1. Cultural experience modulates the self bias effect

Markus and Kitayama (2010) explained the self as inseparable from culture. The identity of the self is formed with different construal styles that are influenced by one's cultural background. Psychologists have proposed two contrasting cultural categories

known as independence vs. interdependence or individualism vs. collectivism (Markus & Kitayama, 1991; Triandis, 1989). A key distinction between the two categories is based on the definition of the self and its relationship with others. The core value of independent societies is the perception of the self as a unique individual that is autonomous and independent from others (Markus & Kitayama, 1991). This value encourages the individual to discover and express one's unique traits, and personal characteristics and accomplishments are the basis to the construal of self identity (Hofstede, 1980). Independent societies typically refer to industrialised western societies such as North America and west European countries. In contrast, the core value of interdependent societies is placed on the relationship and connection to close others such as friends and family (Markus & Kitayama, 1991). Maintaining harmony within the group, having common goals and values, as well as self-sacrifice for the better of the group takes priority over personal needs (Triandis, 1995). Group membership plays an important role in the formation of an interdependent self-identity (Hofstede, 1980). Interdependent societies typically refer to East Asian countries such as China, Korea, and Japan.

Hence, information processing for self and other related stimuli can be different depending on one's cultural background. For independent individuals, processing for self-related information is more separate and unique whilst interdependent individuals process close others, such as mother, in similar ways to self-related information (e.g. reduced differences in RTs and accuracy between self and close other) (e.g. Chiao et la., 2009; Sui, He, & Humphreys, 2012; Zhu, Zhang, Fan, & Han, 2007).

Although westerners are typically viewed as more independent and easterners are perceived as more interdependent, both construal styles exist within the same individual. It is important to know that no one is restricted to being only independent or

interdependent, and that the self is a dynamic concept that changes depending on the context (e.g. Ng & Lai, 2011; Nisbett, Peng, Choi, & Norenzayan, 2001; Oyserman, Coon, & Kemmelmeier, 2002). Cultural priming has been shown to successfully switch between independent and interdependent frames of mind in mono-cultured participants. Simple tasks such as circling pronouns or writing about independent and interdependent themes have elicited interdependent or independent behaviours and thoughts respectively (e.g. Brewer & Gardner, 1996; Trafimow, Triandis & Goto, 1999). Cultural priming is particularly effective when the primed culture is incongruent with the default culture of the participant (Gardner et al., 1999; Sui, Hong, Liu, Humphreys & Han, 2013). This means that interdependent priming is most successful in Western participants and independent priming is most effective in Eastern participants. Thus, cultural background and social contexts are important factors that could modulate the self bias effect.

1.1.2.2. Important life events affect the self bias effect

Major life developments such as the transition into motherhood can also impact the concept of the self mentally and behaviourally as the woman assumes the role of the mother (Mercer, 2004). Evolution encourages the protection of one's offspring to ensure survival (Preston, 2013). The development of maternal sensitivity to infant cues is crucial to effective caregiving and the survival of the infant (Young et al., 2016). Maternal sensitivity refers to the mother's awareness and response to infant cues such as crying (Ainsworth, Blehar, Waters, & Wall, 1978), and a mother's willingness to shift her focus of attention in response to infant cues is an indication of high maternal sensitivity (Meins, Fernyhough, Fradley, & Tuckey, 2001). Motherhood requires changes to one's life and to restructure one's goals, behaviours and responsibilities in

response to the infant (Barba & Selder, 1995). This altruistic act of care provision suggests that infant cues may be processed with similar or even greater priority over self stimuli in mothers due to the biological tendency for altruistic caregiving. Thus, the transition into motherhood is another factor that could modulate the self bias effect.

1.1.3. Explanations for the self bias effect

Due to the robustness of the self bias effect, many have tried to explain this phenomenon in relation to the reward system. Some researchers have speculated that self-related information is processed with priority due to higher intrinsic reward associated with self-related stimuli (e.g. Saxe, 2008; Tamir & Mitchell, 2012). In other words, the brain is thought to perceive self-related information as having higher reward value than non-self-related information. Though attempts to explain self and reward processes have been made (e.g. Northoff & Hayes, 2011), the relationship between self processing and reward processing is still unclear. Thus, the section below will introduce previous research on self-related processing in relation to reward in an attempt to explain the underlying mechanisms of the self bias effect.

1.1.3.1. Reward processing and self processing

High reward shares similarities with self-related stimuli in that both attract more attention than other stimuli. Self-related information not only results in faster responses but is also particularly hard to ignore even when presented in various orientations and locations or presented as a distractor to the actual target (e.g. Brédart, Delchambre, & Laureys, 2006; Gronau, Cohen, & Ben-Shakhar, 2003; Keyes & Brady, 2010). Similarly, stimuli associated with high reward are also processed with greater speed than those with lower reward, and high reward distractors are also more difficult to

ignore (e.g. Anderson, Laurent, & Yantis, 2011a, 2011b; Bucker, Silvis, Donk, & Theeuwes, 2015).

Current research on social and reward processing have shown inconsistent results. Some behavioural studies have found better performance (i.e. faster RTs and higher accuracy) for stimuli associated with self or high reward rather than those with stranger or low reward (e.g. Izuma, Saito, & Sadato, 2008; Sui & Humphreys, 2015). Neuroimaging studies found evidence that demonstrated the recruitment of the reward system during self processing. Brain regions such as the ventromedial prefrontal cortex and the nucleus accumbens, which are known neural circuits for reward processing, were also activated during self-related processing, suggesting an overlap of the self and reward processes in these regions (e.g. de Greck et al., 2008; Phan et al., 2004). However, other research has demonstrated parallel processing of self and reward (e.g. Berridge, Robinson, & Aldridge, 2009). For example, one study using multi-voxel pattern analysis found that the anterior part of the ventromedial prefrontal cortex was engaged in both self and reward processing while the posterior ventromedial prefrontal cortex was only associated with self processing (Yankouskaya, Humphreys, Stolte, Stokes, Moradi, & Jie, 2017). Hence, no conclusive decision has been reached on whether the self bias effect can be explained by reward processes.

The electrophysiological responses to self-related stimuli and high reward are also different from other stimuli. In EEG studies, presentation of self-related stimuli (e.g. self-name, self-face) elicited contrasting levels of activities than non-self stimuli. For instance, both the N1 and P300 components have shown increased amplitudes in response to self-related and high reward stimuli relative to stimuli associated with others and low reward values (e.g. Sato et al., 2005; Tacikowski & Nowicka, 2010; van den Berg, et al., 2014), due to the heightened emotional significance of the stimuli.

However, hardly any studies have compared the EEG responses to both self and reward processing, which have resulted in a gap in current research. EEG may be a crucial step in understanding the relationship between self and reward processing due to its higher temporal resolution and the study of the electrophysiological responses from the entire scalp. Incorporating this technique into the study of self and reward processes may provide important insight on the underlying mechanisms for the self bias effect.

1.2. Research goals

The preceding review has discussed the background and previous research on the self-related processing and self bias. However, current understanding of the subject is still limited. Thus, this thesis aims to address three key questions regarding the self bias effect: 1) What factors can modulate the self bias effect? 2) What are the potential mechanisms that underlie the self bias effect? 3) Whether the self bias effect could predict other concepts of the self such as trait characteristics (e.g. self-construal, self-esteem).

The first part of the thesis (Chapters 2-4) examines the social factors that could modulate the self bias effect. The hypothesis is that the self bias effect can be modulated by factors such as cultural background, social context and major life developments, due to the dynamic concept of the self. The second part of the thesis (Chapters 5 and 6) investigates the mechanisms of the self bias effect in relation to reward processes. The prediction is that if self-related information is processed with the same underlying mechanism as reward processes, then similar patterns of behavioural and electrophysiological results will be found between the self and reward experimental tasks. However, if self and reward processes do not share the same underlying mechanisms, then different patterns of behavioural and electrophysiological results will

be observed between the two tasks. The last part of the thesis (Chapter 7), studies the link between the self bias effect and other concepts of the self such as trait characteristics using correlation analyses from a social psychology perspective.

Through this research, the goal is to gain a better understanding of the self bias effect and contribute to current research in self-related processing.

1.3. Research methods

This thesis uses a perceptual matching paradigm as the main experimental task. This paradigm was first introduced by Sui, He and Humphreys (2012). Compared with previous research, this paradigm does not use self-related items as stimuli. Instead, the stimuli consist of newly learned associations between geometric shapes (triangle, rectangle and circle) and personal-labels (self, friend and stranger). For example, the participants are instructed to associate the self with triangle, friend with rectangle and circle with stranger. During testing, participants view combinations of a shape with a label and make judgments on whether the presented shape and label pair match the correct association or not. The self bias effect is observed in the response differences between the self association and other associations (e.g. friend association, stranger association), and is calculated with the differences in RT or accuracy between the self association and other associations (e.g. friend association, stranger association). The versatility of this paradigm allows testing in various contexts throughout the thesis.

Three forms of methodological approaches have been employed in this thesis to analyse the self bias effect through the perceptual matching paradigm. First, the behavioural approach measures the reaction times (RTs) in response to each association and the d-prime (*d'*) in terms of accuracy. Second, the electrophysiological approach explores the self bias effect through event-related potentials (ERP) of the brain. Third,

self-reported questionnaires look at the correlations between self-reported questionnaire measurements and the behavioural results. The following sections will briefly discuss each of these methodological approaches.

1.3.1. Behavioural approach

Most of the experiments in this thesis used behavioural methods. This includes data on reaction times and accuracy collected through the perceptual matching tasks. Reaction times in response to the self and other stimuli are collected, and the strength of the self bias effect is calculated by the reaction time differences between the self and other stimuli. Data analyses on reaction times consist of responses from match trials and not mismatch trials. This is due to the fact that processing of match trials is a more direct reflection of the cognitive processes behind information processing. Whereas responses for mismatch associations involve more complex procedures that cannot be directly observed through overt behavioural responses. Thus, this thesis focused on the analyses of data from the match trial. Instead of reporting accuracy, d-prime is calculated as a measure of sensitivity to the stimuli. This refers to one's sensitivity to discriminating the target stimuli from background noise such as discriminating match and mismatch trials across different association conditions. It is calculated with the accuracy of the experimental conditions using the Green and Swets (1966) formula:

$$d' = z(\text{hit rate}) - z(\text{false alarm rate})$$

1.3.2. Electrophysiological approach (ERP)

One disadvantage to the overt behavioural approach, however, is that the responses are the outcome of multiple cognitive processes that take place in the brain

(Fields & Kuperberg, 2012). This means that the processes that occur between stimuli and response are unknown and cannot be measured directly by behavioural responses. The ERP technique, on the other hand, measures the electrical potentials that travel through the brain. The distribution of the electrical potentials over the scalp can help locate specific cognitive processes (Luck, Woodman & Vogel, 2000). ERP can also record the continuous neural activities that occur between stimulus onset and overt response (Luck, 2014). As a result, Chapter 6 takes advantage of the temporal resolution of the ERP technique as another approach to investigate the underlying mechanisms of self-related processing and its relationship with the reward system.

1.3.3. Self-reported questionnaires

In addition to behavioural data, self-reported questionnaire data were also collected during each study and reported in this thesis. The goal is to examine the self bias effect from a social psychology perspective, and to test whether the self bias effect could be linked to other concepts of the self such as trait characteristics. The questionnaires collected throughout the thesis include the following: Individualism and Collectivism scale (Singelis, Triandis, Bhawuk & Gelfand, 1995), Self Construal Scale (Singelis, 1994), Rosenberg Self Esteem scale (Rosenberg, 1965), Self Monitoring Scale (Snyder, 1974), Positive and Negative Affect Schedule (PANAS) (Watson, Clark, & Tellegen, 1988), Personal Distance Scale (Sui & Humphreys, 2015), Maternal Postnatal Attachment Scale (Condon & Corkindale, 1998), Sensitivity to Reward Scale (Torrubia et al., 2001) and the Behavioural Activation System (BAS) (Carver & White, 1994). Not all of these questionnaires were used in every study. Some questionnaires are specific to the aim of the experiment, for example, the Maternal Postnatal Attachment Scale (Condon & Corkindale, 1998) is only collected for Chapter 4, and the

Sensitivity to Reward Scale (Torrubia et al., 2001) and the Behavioural Activation System (Carver & White, 1994) are only administered in Chapters 5 and 6. The use and purpose of each questionnaire will be discussed in further detail in Chapter 7, where correlation analyses are fully reported.

1.4. Significance of the current thesis

In general, the goal of this thesis is to provide a better understanding of the self bias effect. In particular, the self bias effect will be studied from the following three aspects: 1) what are the factors that could modulate the magnitude of the self bias effect? 2) what are the underlying mechanisms of the self bias effect? 3) whether the self bias effect could be linked to other concepts of the self such as trait characteristics (e.g. self-construal, self-esteem)? The investigation of the self bias effect from these three aspects will provide a more comprehensive view and contribute to current research on self-related processing.

Additionally, the factors that modulate the self bias effect will provide further evidence that the self is a dynamic concept that can be accessed differently (e.g. independent or interdependent frames of mind) in combination with the social environment. In particular, Chapter 4 explores the cognitive changes in women who recently gave birth. To the best of my knowledge, this is the first study of its kind, focusing on the perceptual changes of the adult women as a result of childbirth or motherhood. Traditionally, researches on the mother-infant dyads mainly focus on the development of the infant (e.g. Bergman, Sarkar, Glover, & O'Connor, 2010; Gutierrez-Galve, Stein, Hanington, Heron, & Ramchandani, 2015; Kingston, Tough, Whitfield, 2012) or the emotional aspect of the mother (e.g. Barrett et al., 2012; Beebe et al., 2007; Leahy-Warren, McCarthy, Corcoran, 2012). However, little to no research

has been found on the self-related processes as a result of the transition into parenthood. Therefore, this particular study introduces a new perspective on the mother-infant relationship. Moreover, the design of the mother-infant study can be applied to testing other parent child relationships such as father and infant or adoptive parent and infant. Further testing with the design of the study can provide more opportunities to understand how the parent-infant relationship evolves as the infant grows older. This could potentially expand the direction of current research into many areas of study and provide more insight on understanding the parent child relationship.

This thesis utilises the perceptual matching paradigm developed by Sui, He and Humphreys (2012), *see Figure 1 for a demonstration of the perceptual matching paradigm*. The significance of this paradigm is that the geometric shapes are universally found in almost all cultures. This eliminates any pre-existing cultural biases that may otherwise influence test results. Previously researches have often used faces (e.g. Sui, Liu, & Han, 2009) and texts (e.g. Chiao et al., 2009; Zhang & Mittel, 2007) as stimuli to study the self. These stimuli may introduce confounding variables because visual familiarity of faces and language processing are difficult to control. Moreover, self-faces and self-related information in other forms also carry certain degrees of personal significance. However, associations with geometric shapes eliminate these confounding factors and make the stimuli less susceptible to any predispositions. Additionally, the fast presentation of the stimuli (100 ms) may reduce possible cultural or linguistic influences on the participants, and the counterbalance of the shape-label associations across participants would also make the results more resistant to pre-existing biases. Due to these advantages, the paradigm is particularly suitable for making comparisons between conditions, such as cross-culture comparisons or comparisons between self and reward processing.

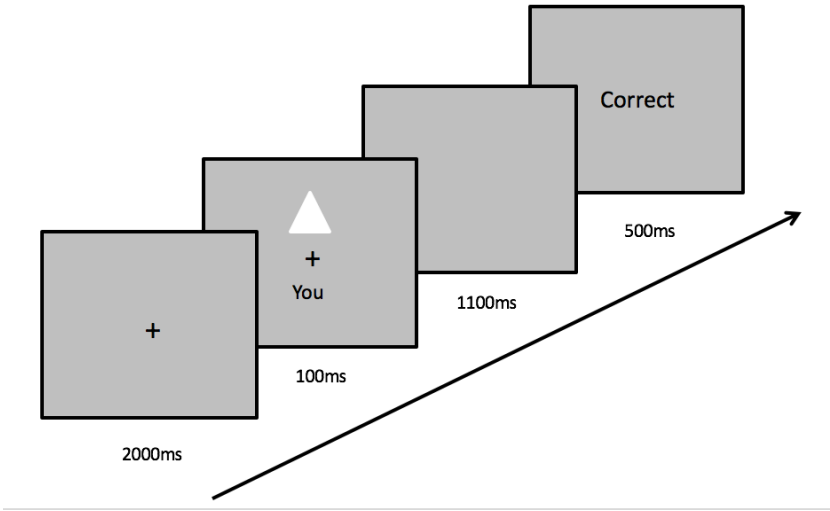


Figure 1. An example of the trial procedure for the perceptual matching paradigm.

1.5. Structure of the thesis

This thesis is composed of two parts. Part one focuses on the modulation of the self bias effect through three experiments, reported in Chapters 2, 3 and 4, which examined the effect of social experiences on the modulation of self bias. Part two of the thesis explores the underlying mechanisms of the self bias effect through two experiments, reported in Chapters 5 and 6, which compared the differences between self and reward processing. The following section will provide a brief summary for each of the above mentioned chapters.

1.5.1. Modulation of the self bias effect

Chapter 2 begins the exploration of the self on a larger scale by comparing differences in self bias between two cultural groups. Independence and interdependence are key characteristics that describe Western and Eastern cultures. Typically, Western cultures are characterised by more independent self, where the self is viewed as unique

and autonomous. In contrast, Eastern cultures perceive the self as more interdependent and value the social embeddedness of the self among family and friends. Hence, this chapter compares the magnitude of the self bias effect in British and Hong Kong participants. Additionally, data from self-reported questionnaires are collected - Individualism and Collectivism Scale, Self Construal Scale, Self Monitoring Scale, Rosenberg Self Esteem Scale, Positive and Negative Affect Schedule, and the Personal Distance Scale – which are analysed and discussed in Chapter 7. The prediction is that the self bias effect from each participant group would correspond with its cultural background. Thus, the hypotheses are that British participants would demonstrate stronger self bias relative to friend and stranger stimuli than Hong Kong participants, and that the Hong Kong participants would show little to no self-bias relative to friend stimuli.

However, it is important to understand that the self is not a fixed concept. Rather, the self is the combination of some key characteristic of the long-term self and the immediate situation (McGuire, McGuire, Chile, & Fujioka, 1978; McGuire & Padawer-Singer, 1976). It is a dynamic entity that is highly temporary and malleable (Markus & Kunda, 1986; Markus & Wurf 1987). This means that the self has access to both independent and interdependent construals and can adapt to various situations and adjust one's behaviours according to the expectation of the social context.

Thus, Chapter 3 explores whether situational primes could modulate the self bias effect. Usually the more prominent framework is referred to as one's default culture. This typically refers to independent self for people from Western cultures, and interdependent self for people from Eastern cultures. The goal of this chapter is to test whether priming for different self construal styles could motivate participants to shift between the independent and interdependent frames of mind within the same

individual. Similar to Chapter 2, this study also consists of three shape-label associations (i.e. self, friend, stranger), but the participant group is only composed of British volunteers. Each participant performed the perceptual matching task under three conditions – neutral (i.e. no priming), independent priming, interdependent priming. The questionnaires administered in this study are the same as the questionnaires in Chapter 2. The prediction was that successful interdependent priming on British participants would result in reduced self bias relative to friend stimuli in comparison to the self bias relative to stranger.

Other than the effect of culture on the self bias effect, major life events also impact self perception. Chapter 4 focuses on investigating the self bias effect during major life developments, specifically the transition into motherhood for women. A mother's sensitivity to the detection and response to the infant's cues is particularly important for effective caregiving and the survival of the infant. The provision of care often requires sacrifices on the mother's part where the infant's needs are placed above the needs of the mother. This altruistic act of care provision indicates the possibility that infant-cue may be processed with greater priority over self stimuli in mothers. In this study, participants consist of women who recently gave birth and became mothers. The perceptual matching task is also modified so that five shape-label associations – infant, self, mother (i.e. grandmother to the infant), friend, stranger – was used instead of three from the previous chapters. The questionnaires in this study consist of the Maternal Postnatal Attachment Scale and the Personal Distance. The hypothesis is that mother sensitivity to infant-stimuli would decrease the self bias relative to infant stimuli and the mother (i.e. the self) would show a bias towards infant-stimuli rather than the self. The bias toward infant stimuli is hypothesised to correlate with maternal postnatal attachment.

1.5.2. Exploration of the underlying mechanisms of the self bias effect

Some researchers have explained prioritised self-processing as the result of intrinsic reward due to its recruitment of the reward system. Indeed, activity in certain brain regions in response to self stimuli highly overlaps with the neural circuits of reward processing (e.g. De Greck et al., 2008; Northoff & Hayes, 2011), which suggests that self-relevant information is regarded as having a higher reward value than other information. However, other brain imaging studies contradicts this and have found no significant overlap between self and reward processes (e.g. Berridge, Robinson, & Aldridge, 2009).

To investigate the relationship between self and reward processes, Chapter 5 compares reward associations with personal associations using the perceptual matching task. Participants performed two perceptual matching tasks, one associated with reward values and another with personal labels. The experiment investigated whether similar biases would be observed for self-related and reward-related stimuli. This study provided a direct comparison between reward and self processes through the same paradigm. In addition to the questionnaires used in Chapter 3, two reward questionnaires – Behavioural Activation System and Sensitivity to Reward – were also used to measure reward drive. The predictions are that if the self bias effect is the result of high intrinsic reward value, then the behavioural responses would show the same patterns between the reward and self perceptual matching task. However, if the two processes are separate, the behavioural results would show different patterns.

Chapter 6 further investigates the relationship between reward and self processes by taking advantage of the temporal resolution of the ERP technique. Similar to Chapter 5, this study also consists of two perceptual matching tasks. However, the

shape was presented first followed by the label in separate steps instead of presenting the shape-label pair simultaneously. ERPs are also recorded during the task to measure the electrophysiological responses to each shape stimulus. The questionnaires used in this study are the same as in Chapter 5. It was hypothesised that the self and high reward stimuli would elicit differential responses compared with the other stimuli. Specifically, the pattern of ERP results would be comparable if self processing shared similar mechanisms to the reward system. Contrastingly, different patterns of ERP results would indicate separate processing between self and reward.

Chapter 7 reports the correlation analyses of the self-reported questionnaires administered throughout the previous experimental chapters. Given that the sample size in each study is relative small compared to social psychology standards, responses from multiple chapters are combined together to increase the validity of the questionnaire results. It is predicted that the self bias effect would correlate with measures of independence and interdependence in self construal questionnaires as well as other questionnaires such as self esteem, self-monitoring, positive and negative affectivity, and personal distance. Chapter 5 and 6 are predicted to demonstrate correlations between the bias towards self and high reward if the two shared the same underlying mechanisms.

The final chapter – Chapter 8 – discusses the overall findings of this thesis as well as its significance and integration into current research. Limitations and future research are also reported. Overall, this thesis studies the modulation of the self bias effect from social factors as well as its relationship with reward processes.

Chapter 2

Cultural orientation of self bias in perceptual matching

Abstract

Previous research on cross-culture comparisons found that Western cultures tend to value independence and the self is construed as an autonomous individual, while Eastern cultures value interdependence and self-identity is perceived as embedded among friends and family members (Markus & Kitayama, 1991). The present experiment explored these cultural differences in the context of a paradigm developed by Sui, He and Humphreys (2012), which found a bias towards the processing of self-relevant information using perceptual matching tasks. In this task, each shape (i.e. triangle, circle, square) is associated with a person (i.e. self, friend, stranger), and self-associated stimuli resulted in faster and more accurate judgements than non-self stimuli. With this paradigm, the current study examined cross-cultural differences in the self bias effect between participants from Hong Kong and the United Kongdom. Results demonstrated a reliable self-bias effect across groups consistent with previous studies. Importantly, a variation was identified in a larger self-bias towards stranger-associated stimuli in the United Kingdom participants than the Hong Kong participants. This suggested the cultural modulation of the the self bias effect in perceptual matching.

Keywords: cross-culture comparison, independence and interdependence, perceptual matching, self-bias effect

2.1. Introduction

The 'self' is an important concept that has been the focus of different fields, from social psychology, cross-culture psychology to social cognitive neuroscience. Many have attempted to decode and explain what the self is in the mind and brain. In recent years, much literature has focused on cultural differences between the East (e.g. East Asia) and the West (e.g. North America and Western Europe). These differences have been referred to as Individualism versus Collectivism by Triandis (1989), or Independence versus Interdependence by Markus and Kitayama (1991), and the concept of the self in relation to others is one of the key distinctions between the East and the West (Gardner, Gabriel & Lee, 1999). This study investigates the impact of cultural experiences on the self bias effect in British and Hong Kong participants.

Cultural experiences play a crucial part in forming the concept of the self. The self is developed through interactions with, not only other people, but also the social environment and cultural background (Kitayama, Duffy, & Uchida, 2007; Markus & Kitayama, 2003). Markus and Kityama (1991) stress the importance of independence and interdependence in self-identity. In particular, Western cultures tend to emphasise independence and perceive the self as distinct autonomous entities unique from other people. This encourages one to discover and express one's unique attributes. In order to achieve independence from other people, one's self-identity is formed with reference to one's own internal thoughts, feelings, motivations and actions irrespective of other people, *see Figure 2-A*. Eastern cultures, however, place greater emphasis on interdependence, which refers to the interconnectedness of oneself to other people and group membership forms an important part of self-identity. This is reflected in the overlap of one's concept of the self to other people, *see Figure 2-B.*

Typically, one's levels of independence and interdependence are measured through self-reported questionnaires such as the Self Construal Scale (Singelis, 1994) and the Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995). The focus of these questionnaires is to measure one's relationship with others and the extent to which representations of the self are perceived as separated or connected with family and friends (Markus & Kitayama, 1991).

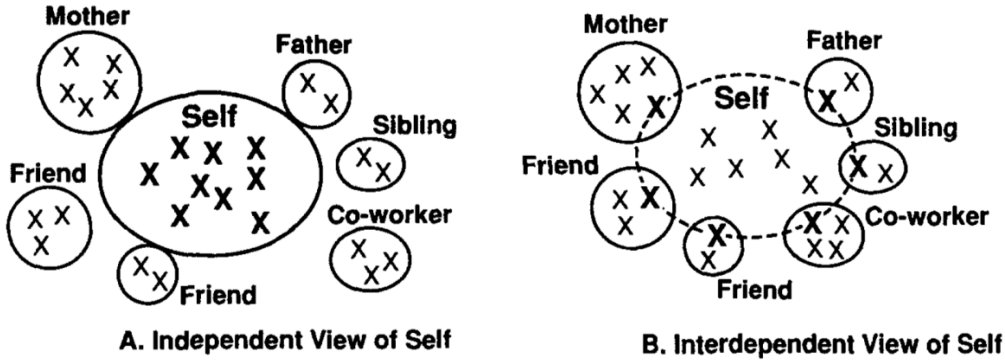


Figure 2. Self-identity in relation to others, as described by Markus and Kitayama (1991) (A: independent self. B: interdependent self). Xs indicates one's representations of the self.

Cultural differences not only influence the concept of the self but also affect one's perception and cognition. East Asians tend to live in a highly interdependent society where attention is directed more to relationships with other people. Westerners, however, live in a more independent society where less attention is paid to the social context. This cultural difference impacts the way stimuli are perceived in the environment. Many have found that Westerners pay more attention to salient objects

than contextual background and that Easterners detect contextual relations more than specific items (Nisbett & Miyamoto, 2005). For example, Masuda and Nisbett demonstrated this attention difference by asking the participants to view and describe a series of vignettes and pictures. In one study, American students tend to describe the most salient objects first (e.g., "I saw a trout") while Japanese students described the context first (e.g., "I saw a stream"). Results demonstrated that the Japanese students noticed 60% more details about the context than the American students (Masuda & Nisbett, 2001). In another study, American and East Asian participants viewed pictures and vignettes that have focal object or contextual information changes. Findings showed that American participants were more sensitive to changes in focal objects than to changes in the periphery or context. In contrast, East Asian participants were more sensitive to contextual changes than to focal object changes (Masuda & Nisbett, 2006). Similarly, Singelis and Brown (1995) reported that the context of the situation easily influences the behaviour of interdependent individuals but not independent individuals. Kuhnen, Hannover, and Schubert (2001) also found that stimulus processing is more affected by context in interdependent than independent self-construals. These findings confirm that culture guides the perception of the self, as well as the way we perceive our environment.

Similar results were also reported by Kitayama, Duffy, Kawamura, and Larsen (2003) through a framed-line test. Participants viewed a square with a line inside and were asked to reproduce the line in another square in either the same absolute length or in the same proportion to the square. The East Asian participants performed more accurately in the relative task than the absolute task. In contrast, the Western participants performed better in the absolute task than the relative task. The Westerners

were also much better at the absolute task than the East Asians, while the East Asians outperformed the Westerners in the relative task.

Eye movement study also demonstrated culturally different viewing patterns. Objects placed into photographs of naturalistic scenes were presented to the participants for viewing. It was found that Americans fixated more on the object, whereas the Chinese spent more time looking at the background (Chua, Boland & Nisbett, 2005). Thus, the context of the situation heavily influences stimulus processes and the responses of the interdependent individuals (Kuhnen, Hannover & Schubert, 2001; Singelis & Brown, 1995).

As a result of the focus on contextual information, people from interdependent cultures have adapted to perceive the self and close others very differently from independent cultures. Memory encoded in self-reference had been found to vary between cultures. Wagar and Cohen (2003) compared Euro-Canadians and Asian-Canadians using a paradigm that cued referential memory with three questions. Each of the questions corresponded to an encoding level – self-reference ("Does this word describe you?"), other-reference ("Does this word describe your best friend?") and word structure ("Is the first letter a vowel?"). Each question was followed by the display of a word that was either a personal trait or a collective trait. The task was to decide whether the trait words applied to the cued questions. Later, a memory test on what words appeared in the previous phase was administered. Results showed that Euro-Canadian participants responded fastest to words encoded in self-reference regardless of trait type. Self-referenced words also elicited significantly quicker response than words encoded in other-reference and vowel structure. The Asian Canadians, however, were only faster to recognise collective traits and much slower

with personal traits, when both were encoded in self-reference. This indicated a strong context-dependent description of the self in Asian Canadians.

Anecdotal memories were also different across the East and the West. Using a self-reported questionnaire, Wang (2001) asked participants to report their earliest childhood memory. American participants reported specific memories that were focused more on individual events (e.g. “when I was 4, I got stung by a bee”) with elaborate and expressive descriptions of emotions and personal experiences. On the other hand, the Chinese memories were more about routine activities within the family or neighbourhood (e.g. “my mum took me to school everyday”), with descriptions that focused on significant others or the relationship with others.

Cross-culture variations were also found in self-face recognition. Sui, Liu, and Han (2009) conducted a study to examine self-face processing using event-related potentials (ERP) in British and Chinese participants. During the study, participants were asked to make judgements about the orientation of target faces that were either self face or a familiar face. Behaviourally, the British participants showed a larger self-advantage than Chinese participants, but performance was faster and more accurate to self-faces than to familiar faces in both British and Chinese participants. ERP analyses revealed larger activity at 280-340ms in the anterior N2 component for self-faces than familiar faces in British participants, while the Chinese showed reduced anterior N2 amplitudes to self-faces than familiar faces. This suggests that self-advantage is universal, but people from different cultural backgrounds develop different strategies to fit with the environment.

The neural representation of the self also differs across culture. Zhu and colleagues (Zhu, Zhang, Fan, & Han, 2007) measured brain activity using fMRI as participants performed a trait judgement task. Similar to the memory test mentioned

above, one of three questions were presented to cue the person to be judged – self, mother, and public figure (other). A null condition was presented between the judgment tasks where participants viewed rows of asterisks. Following the cue question, a trait adjective was presented and the participant decided whether the adjective described the cued person. Results illustrated that relative to the null condition, Western participants showed increased activations in the medial prefrontal cortex in response to self-judgements and reduced medial prefrontal cortex activities to mother-judgements. Unlike their Western counterparts, the Chinese showed enhanced medial prefrontal cortex activity in response to both self-judgements as well as mother-judgements when compared with other-judgements and null condition. These results indicated that while the medial prefrontal cortex is involved in self-representation in both cultures, medial prefrontal cortex also represented mother in Chinese participants.

In a similar study, Chiao and colleagues (Chiao et al., 2009) found different degrees of neural activation within the anterior rostral regions of medial prefrontal cortex due to cultural contrasts. Results found individualists, as revealed by the Self-Construal Scale, showed greater activation in the medial prefrontal cortex in response to general self-descriptions (traits that describe the participant in general) than contextual self-descriptions (traits that describe the participant only under certain conditions such as “when you are talking to your mother”), while collectivists demonstrated greater activation for contextual self-description than general self-description. These findings gave evidence that different cultural values have led to the neural unification or separation of the self in relation to close others.

Nevertheless, the self bias effect has been consistently found in previous studies. Most results consistently showed a prioritisation effect when processing self-relevant information. This bias towards self-stimuli was particularly robust in the perceptual

matching task. Sui, He, & Humphreys (2012) designed a simple shape (i.e., triangle, square, or circle) and label (i.e., self, friend, or stranger) matching task. Participants were asked to learn to associate a shape with a label (e.g., triangle is you, square is your best friend, and circle is a stranger) and were tested by making judgements on whether the shape and label shown on screen matched the associations previously learnt. It was shown that responses were faster and more accurate to the self-associations than to friend and stranger associations.

2.1.1. Objectives and hypotheses of the current study

In collaboration with the University of Hong Kong, the current experiment was conceived to test the cultural differences in self bias between participants from Hong Kong (HK) and the United Kingdom (UK). Though previous studies have examined the cultural differences in cognitive processes such as memory and high-level decision-making (Cunningham et al., 2008; Turk, Cunningham & Macrae, 2008), relatively few have examined low-level processes such as perceptual matching. Moreover, previous research often used stimuli that were highly familiar to the participant (e.g. one's own face or familiar faces). The current study focused on low-level processing in perceptual matching by using geometric shapes as stimuli. Geometric shapes such as triangle, circle, and square are commonly found in both Western and Eastern cultures. This means that confounds such as familiarity (in studies using familiar faces as stimuli) can be controlled by making associations with neutral geometric shapes. Additionally, geometric shapes also control for any cultural predispositions or self-relevant information carried by the stimuli prior to learning the associations. Thus, the perceptual matching paradigm (Sui, He & Humphreys, 2012) improves the validity of studies that make comparisons between variables.

The aim of the current study was to examine the difference in the relationship between self and others in independent and interdependent cultures using the perceptual matching paradigm. In interdependent cultures, the self-identity is embedded among the identity of family and friends, and the idea of an individual self is less pronounced. As a result, it was expected that one's reaction time to friend stimuli should not be significantly different from that of the self-stimuli because the friend-stimuli are a reflection of the self, *see Figure 2-B*. In contrast, individualistic cultures promote an autonomous self, which should be reflected in a stronger sense of the individual, resulting in a faster response to the self when compared to other associations, *see Figure 2-A*. Based on these ideas, it was hypothesised that the self bias effect relative to friend would be significantly smaller in HK than in UK participants in perceptual matching.

Thus, this study examined the modulation of the self bias effect as a result of cultural orientation in HK and UK participants.

2.2. Method

2.2.1. Participants

Altogether 56[1] volunteers took part in this study. Of these, 32 healthy Caucasian volunteers (10 male, 18 to 35 years of age, mean age ± standard deviation = 22.22 ± 4.51) were recruited in the UK and tested at the University of Oxford; 24 healthy Chinese volunteers (5 male, 18 to 24 years of age, mean age ± standard deviation = 19.92 ± 1.91) were recruited in Hong Kong and tested at the University of Hong Kong. Hong Kong participants were bilingual and had not previously studied overseas for

[1] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 26 subjects were required to achieve *power* = .80, α = .05.

more than one year. All participants were right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment. The procedure used in this experiment was ethically approved by the University of Oxford Central University Research Ethics Committee and the University of Hong Kong Human Research Ethics Committee.

2.2.2. Stimuli and materials

The computer task was displayed on different sized monitors, with different degrees of visual angle, in the UK and HK studies. In the UK, a white fixation cross was presented at the centre of the screen at 0.8 x 0.8 degrees of visual angle. Then, one of three geometric shapes (triangle, square, or circle) was presented above the fixation cross at 3.8 x 3.8 degrees of visual angle, and one of three personal labels (you, friend, or stranger) was presented below the fixation cross at 3.1/3.6 x 1.6 degrees of visual angle. The association of shapes with labels was counterbalanced across participants. The distance between the shape/label to the fixation cross was 3.5 degrees of visual angle. All stimuli were presented in a grey background on a 23-inch monitor (1920 x 1400 at 60 Hz). The programme was run on a PC using E-prime software (version 2.0). All stimuli were consistent with those used in the Sui, He, and Humphreys (2012) study. In Hong Kong, the white fixation cross was presented at 0.4 x 0.4 degrees of visual angle. The three geometric shapes were presented at 3.3 x 3.3 degrees of visual angle, and the three labels were presented at 2.0/4.3 x 0.9 degrees of visual angel. The distance between the shape and the fixation cross was 1.8 degrees, and the distance between the label and the fixation cross was 1 degree. Stimuli were presented in a grey background on a 17-inch monitor (1024 X 768 at 60 Hz). The programme was run on a PC using E-prime software (version 2.0).

To determine the effects of testing using different parameters, 12 participants in the UK were tested using the HK specifications. However, I was unable to locate a 17-inch monitor, so a 13-inch monitor was used instead to determine whether the smaller screen affected the results. All stimuli presented were identical to the ones used in HK. A mixed design ANOVA was performed within the UK participants using the group with different parameters as a between-subject variable. No significant differences were found between the two groups, eliminating the parameters as a confounding variable. As a result, data from all participants were included in the final analyses.

Questionnaires were implemented in the experiment to measure the relationship between behavioural responses and trait characteristics. This included the Self Construal Scale (Singelis, 1994), Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995), Self Esteem Scale (Rosenberg, 1965), Self Monitoring Scale (Snyder, 1974), Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) and the Personal Distance Scale (Sui & Humphreys, 2015), *see Appendices A.1 – A.6 correspondingly*.

2.2.3. Procedure

Each participant conducted a word search task and a computer-based matching task twice, *see Figure 3*. A questionnaire booklet was completed at the end of the study. The purpose of the word-search task was to ensure that each participant performed the computer task in their default cultural frame of mind – that is independence for UK participants and interdependence for HK participants. The word search task consisted of two short texts with no pronouns that described a tourist destination (Sui & Han, 2007), *see Appendix B.1*. This made sure that the participants were tested at baseline where no cultural priming would occur as a result of pronouns such as ‘I’ or ‘we’. Participants

were instructed to read each text and circle target nouns in the text (such as *park, area, pyramid, giza, sphinx*). The number of target words was the same for both texts. Verbal instructions were given for participants to read each text three times to make sure all target words were found. After each text, participants subsequently performed a perceptual matching task on the computer.

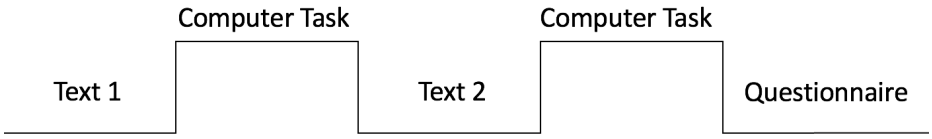


Figure 3. Task procedure alternating between word-search task and computer task.

For the computer task, participants first learned to associate a shape with a label. For example, the triangle represents you, the square represents your best friend, and the circle represents a stranger. Verbal and oral instructions were given as the participants learned the correct associations, though shape images were not presented at this stage. The learned associations remained the same throughout the two computer tasks for each participant. At the beginning of each trial, a fixation cross was presented at the centre of the screen for 2000 ms, followed by a pairing of a shape with a label above and below the fixation cross for 100 ms. The shape and label either matched the associations previously learned or was a recombination of a shape with a label randomly generated by the computer. Next, the screen remained blank for 1100 ms, during which time participants had to judge whether the shape-label pair matched or not by pressing one of the two buttons as quickly and accurately as possible with one of two index fingers, *see*

Figure 4. Following each response, feedback (green "Correct" or red "Incorrect") was given on the screen for 500 ms at the end of each trial. If no response was given within the 1100 ms window, the feedback "Too Slow!" was displayed in yellow to prompt faster responses. Feedback on overall accuracy was provided at the end of each block. Participants performed 9 practice trials and three blocks of 60 trials following each word-search task. This cycle of word search task and computer task was repeated twice. After completing all the word-search tasks and the computer-based tasks, participants filled out the questionnaire booklet, *see Figure 3*.

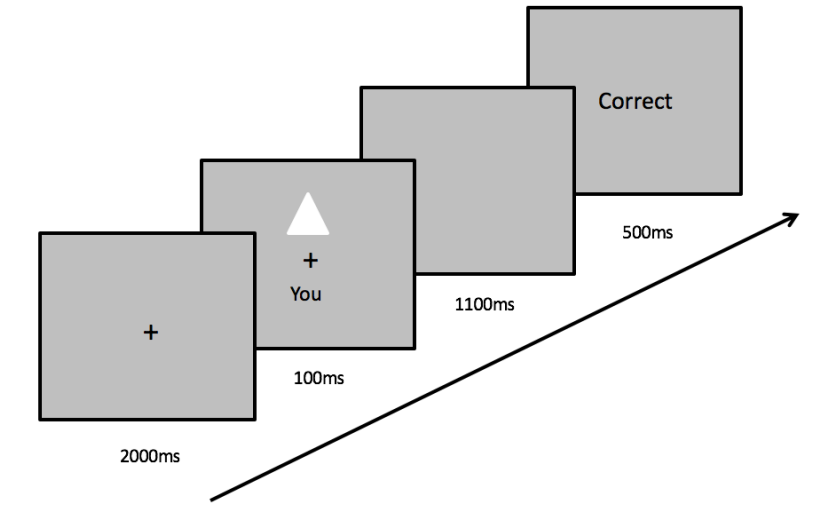


Figure 4. The trial procedure and an example of the stimuli for the computer task.

2.2.4. Experimental design and data analyses

Reaction times (RTs) from the UK and HK data were normalised by calculating the difference between two associations divided by the sum of the same two associations (i.e. (A-B)/(A+B)) to equate for possible group differences in the range of RTs. In other words, the normalised score between self and friend was calculated using

(friend RT – self RT)/ (friend RT + self RT) and the normalised score between self and stranger was calculated using (stranger RT – self RT)/ (stranger RT + self RT). This method of normalising the results make comparisons between two associations, which is in line with the goal of this experiment. Results were reported in normalised RTs for match trials. The results of the ANOVAs on the normalised RTs between self and friend and the normalised RTs between self and stranger were reported. Finally, analyses of d-prime were also performed. Holm-Bonferroni corrections were applied to all multiple comparisons (Holm, 1979).

2.3. Results

2.3.1. RTs in match trials

Since this study mainly focused on examining the difference between self and others, mixed-design ANOVAs were performed on the normalised RTs between self and friend and between self and stranger. The type of normalised RTs (between self and friend or between self and stranger) was used as the within-subjects variable and culture group (HK vs UK) as the between-subjects variable. A significant main effect was found on normalised RTs type, $F(1, 54) = 6.28$, $p < .05$, $\eta^2 = .10$, *see Table 2*, but not on culture group, $F(1, 54) = 2.15$, $p = .15$. In other words, a larger difference was observed in the normalised RTs between self and stranger than between self and friend ($p < .05$) across participants from both culture groups. A significant interaction between the type of normalised RTs and culture group was found, $F(1, 54) = 4.48$, $p < .05$, $\eta^2 = .08$, *see Table 1 for mean match RTs and Table 2 for mean normalised match RTs*.

Table 1. Mean RTs (ms) and SDs (in brackets) for match trials as a function of association and culture group.

Associations	UK	HK
Self	632 (68)	649 (59)
Friend	695 (64)	706 (52)
Stranger	722 (56)	709 (62)

Table 2. Mean normalised RTs (ms) and SDs (in brackets) for match trials as a function of bias and culture group.

Normalised RTs	UK	HK	Mean
Self & Friend	.05 (.04)	.04 (.03)	.05 (.04)
Self & Stranger	.07 (.04)	.04 (.04)	.06 (.04)

Independent samples t-tests were performed to decompose the two-way interaction between the type of normalised RTs and culture group. A significant difference in the normalised RTs between self and stranger was found between the UK and the HK participants, $t(54) = 2.12$, $p = .039$, $dz = .75$, *see Table 2 and Figure 5*. The normalised RTs between self and friend, however, were not significantly different between the UK and HK participants, $t(54) = .50$, $p = .617$, $dz = .28$, *see Table 2 and Figure 5.* Though different from the intial hypothesis, a difference in self bias (relative to stranger) was still identified between the two culture groups.

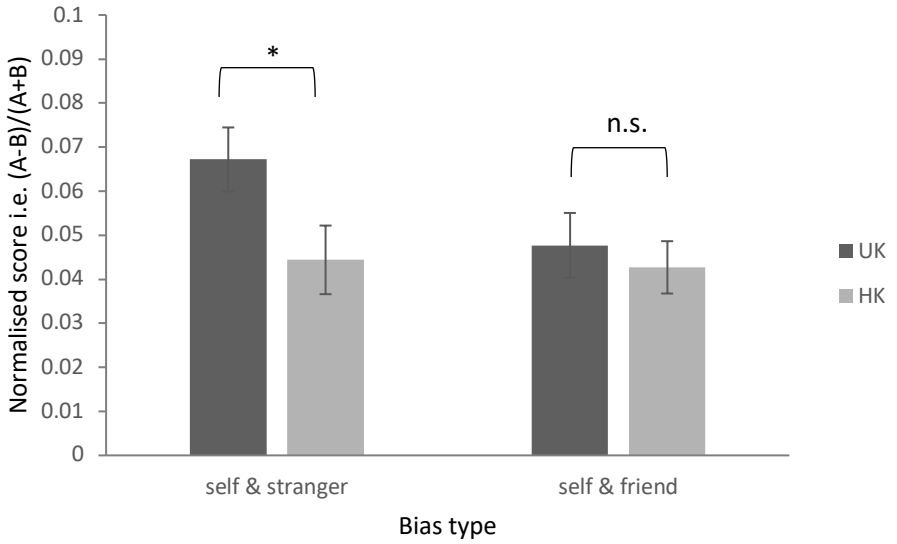


Figure 5. Interaction between normalised RTs calculated using (A-B)/(A+B) and culture group. Error bars represent one standard error. Significant differences are marked with ''.*

2.3.2. D-prime

Using the Green and Swets (1966) formula, d-prime was calculated for each participant to determine their sensitivity to correct and incorrect associations across both match and mismatch shape-label associations. This sensitivity refers to how difficult it was for the participant to discriminate the target stimuli from background noise and was calculated using the accuracy of the match and mismatch conditions.

A mixed-design ANOVA was performed on the d-prime values, using the shape-label association (self, friend, or stranger) as the within-subjects variable and culture group (HK or UK) as the between-subjects factor, *see Table 3*. The analysis revealed a significant main effect of shape-label association, $F(2, 108) = 16.71$, $p <$

.001, $\eta^2 = .24$. Pairwise comparison of the shape-label associations indicated that d-prime for the self association was significant higher than for friend ($p < .001$), and stranger associations ($p < .001$). Friend and stranger associations were not significantly different from each other ($p = 1.00$). There was also a significant main effect of culture group, $F(1, 54) = 4.28$, $p < .05$, $\eta^2 = .07$. Larger d-prime was found in the UK participants than HK participants ($p = .05$), *see Table 3*. The interaction between the shape-label association and culture group was not significant, $F(2, 108) = .51$, $p = .60$.

Table 3. Mean d-prime and SD (in brackets) for both match trials and mismatch trials as a function of association and culture group.

Associations	UK	HK	Mean
Self	2.78 (0.74)	2.26 (1.02)	2.48 (0.94)
Friend	2.21 (0.87)	1.86 (0.93)	2.01 (0.91)
Stranger	2.22 (1.11)	1.66 (1.04)	1.90 (1.10)
Mean	2.40 (0.18)	1.93 (0.15)	

2.3.3. Questionnaires analyses

Correlation analyses were conducted to examine the relationship between the behavioral responses and the questionnaire measures. Please see Chapter 7 for the results.

2.4. Discussion

This study explored the cultural influence on the self bias effect in HK and UK participants through the perceptual matching paradigm. The aim of this study was to identify the differences in cultural background as a modulating factor for the self bias effect.

2.4.1. Findings and implications

The initial hypothesis was that due to cultural differences in the emphasis on independent and interdependent self, the self-bias effect relative to friend would be larger in the UK participants than HK participants. Though the results were slightly different from this hypothesis, a cultural variation was still identified between the two cultural groups: The UK participants demonstrated a larger self-bias effect relative to strangers than the HK participants. This difference in the self-bias effect relative to strangers was an indication that independent and interdependent cultural frameworks can modulate the magnitude of the self bias effect. The d-prime results from both culture groups also demonstrated the robustness of the self-bias effect. There was a significant advantage for the self association than for friend and stranger associations in both HK and UK participants. This confirmed the prioritisation in the processing of self-relevant information, consistent with previous research (e.g. Frings & Wentura, 2014; Mattan, Quinn, Apperly, Sui, & Rotshtein, 2015).

However, the UK participants were much more sensitive to all of the stimuli than HK participants, resulting in higher overall d-prime in the UK than in HK participants. The lower d-prime score may be due to the fact that the HK participants found the task more difficult. Previous research found that interdependent samples process objects with reference to the context or background more than Western samples (e.g. Masuda & Nisbett, 2001, 2006; Wang & Ross, 2005). It is possible that this

strategy is not as well-suited for the interdependent subjects of this particular task where the stimuli were presented on a blank background without context. In contrast, Western samples have an advantage over the Eastern samples as they process target objects individually.

Alternatively, the lower d-prime performance in the HK participants may have been a result of testing in a second language (English). One of the criteria for the HK participants was that they must not have studied more than one year abroad. Although this controls for the level of exposure to independent cultures, it also suggests that the participants may not be fluent in the English language. In which case, individuals may have more difficulty detecting the English stimuli. Future research should be conducted to test another group of non-native English speakers using English stimuli and use language as a between-subjects factor to see if there are any significant integrations between English as a second language and task performance. Despite these limitations, the results of our experiment identified a difference in the self bias effect between the two cultural groups.

2.4.2. Significance of this study

The findings of this experiment indicated that cultural variations play a vital role in the way humans process information about ourselves and unfamiliar others. Although previous studies have addressed cross cultural comparisons, the significance of this experiment lies in utilising the shape-label paradigm, which included simple geometric shapes as stimuli (Sui, He, & Humphreys, 2012). Previously, experiments have used stimuli such as faces (e.g. Keenan et al., 1999; Sui, Liu, & Han, 2009) and texts (e.g. Chiao et al., 2009; Zhang & Mittel, 2007) to study self-construal styles. These stimuli may introduce confounding variables because visual familiarity of faces,

as well as complex language processes, are difficult to control. Geometric shapes, however, are universal in both Western and Eastern cultures, which makes it less susceptible to any cultural predispositions. The association of familiar and unfamiliar persons with geometric shapes eliminates the confounding effect of visual familiarity with faces, and remove translational and language problems produced in complex texts. The use of geometric shapes also eliminates any self-relevant information carried by the stimuli prior to learning the association. Thus, this paradigm improves the validity of the cross-cultural comparisons and provides more comparable data without the introduction of prior knowledge.

2.4.3. Limitations and future research

Some limitations of this experiment are as follows. First, HK participants are considered more bicultural than other East Asian cultures. Hong Kong has been the confluence of both Chinese and Western cultures for nearly two centuries. The Hong Kong students recruited in this study may be more representative of a bicultural sub-group than the typical East Asian interdependent group. This may explain the lack of a self bias relative to friend as was initially hypothesised, though further research is needed to fully explain this phenomenon.

Second, the experiment was administered in English in both the UK and the HK groups. Usually experiments that use languages as stimuli are administered in the native tongue to avoid the effects of cultural priming. Participants who used an independent language (i.e., English) show decreased cognitive accessibility of the interdependent self compared to those who used a interdependent language (i.e. Chinese) (Trafimow, Silverman, Fan, & Law, 1997; Wang, Shao, & Li, 2010). Ross, Xun, and Wilson (2002) also reported that bicultural participants were more likely to report more favourable

self-statements when writing in English than in Chinese. According to Kemmelmeier and Cheng (2004), language priming effects primarily occurred for self-construals that were not already salient in the respondents' culture. Despite this, the results of this experiment is still quite robust. Therefore, it is unclear to what extent the language cue has affected these results. Notably, the results showed the cultural effect even with these limitations.

This experiment provides some interesting future research questions. First, it would be interesting to explore the extent of the self-bias effect in relation to family members in cultures which possess different family values. Moreover, the strength of the self-bias against other members such as siblings, spouse, or children have yet to be examined. Interdependent cultures would suggest a stronger embeddedness of the self in one's family members than independent cultures. It would be interesting to examine whether the closeness of one's family member predicts the strength of the self-bias effect and how this effect changes due to cultural values.

Second, it is important to keep in mind that individual differences can exist with culture groups. Some people from independent cultures may be more interdependent and some from interdependent cultures may be more independent. The concept of the self, whether independent or interdependent, is a dynamic concept that can change depending on many factors such as social context (Colzato, de Bruijn, & Hommel, 2012; Markus & Kunda, 1986; Markus & Wurf, 1987; Oyserman, Sorensen, Reber, & Chen, 2009). Hence, future studies should take into consideration that cultural background is not the determining factor on the magnitude of the self bias effect.

In conclusion, this chapter investigated the impact of culture on self and other processing through a new paradigm. The results revealed that compared to their UK

counterparts, HK participants showed reduced self-bias in relation to strangers. This supports the concept that interdependent self-construal style recognises the self as an entity in relation to others while the individualist self is a single independent entity. Hence, cultural background can modulate the self bias.

Chapter 3

The modulation of cultural priming on the self bias effect

Abstract

Recent research has discovered a bias towards the processing of self-relevant information in low-level perceptual matching tasks (e.g. Keenan et al., 1999; Sui, He, & Humphreys, 2012). Judgments for self-associated stimuli are processed faster and more accurately than judgements for friend or stranger associated stimuli. It is also well known that priming of independent or interdependent self construals successfully modulate self-biases in high-level tasks such as self-referential memory. This chapter consisted of two experiments that examined whether the modulating effect of cultural priming on self-processing held for low-level perceptual matching. Experiment 1 employed an implicit priming method, using a word search task to prime independent or interdependent self construal in British participants by circling either independent (e.g. I, me, my) or interdependent (e.g. we, us, our) pronouns. Experiment 2 was identical to Experiment 1, except that an explicit self construal priming method was used, where participants wrote essays on independent (i.e. self-expectations) or interdependent (i.e. family and friends' expectations) themes. After priming, the participants immediately completed the perceptual matching task in which they judged whether shape-label associations matched or not. Findings from Experiment 1 showed a reduced self-bias effect in perceptual matching after interdependent priming in participants who had low self bias compared to those with high self bias, but this was not the case for independent priming. The same effect observed in Experiment 1 was replicated in Experiment 2 with an explicit priming method. Across the two experiments, the data consistently indicated that the self is not a unified concept but can be accessed dynamically through cultural priming.

Keywords: Self-bias, Perceptual Matching, Priming, Culture

3.1. Introduction

The last chapter focused on a cross-culture examination of the self and how cultural experiences in different societies influence the self bias effect. Markus and Kitayama (1991) propose that Western cultures tend to value independence, where the self is construed as an autonomous entity reflecting the goals of the individual. In contrast, Eastern cultures tend to value interdependence and the self is construed as socially embedded among family and friends. In line with these findings, a perceptual matching task was tested among students from Hong Kong and the United Kingdom. It was found that although participants from both culture groups were more perceptually sensitive to the self-associations, HK participants were much faster to respond to stranger-associations than UK participants, which communicates a smaller self-bias toward strangers. This may be explained as a result of the emphasis on interdependence in collectivist cultures.

Although independence and interdependence were previously portrayed as opposing concepts (Hofstede, 1980; Hui, 1988), both self-construal styles co-exist within the same individual (Singelis 1994). In fact, it was found that although European Americans were more independent than other cultures, they were not necessarily less interdependent than East Asians (Oyserman, Coon, & Kemmelmeier, 2002). It was proposed that the two self-construal styles are not mutually exclusive but two parallel dimensions with one more easily accessible than the other (Ng & Lai, 2011). Therefore, this chapter examined the accessibility of independent and interdependent self-construals and the modulation of the self-bias effect through cultural priming.

3.1.1. Previous research on cultural priming

It is possible for cultural primes to shift the weight of judgments from independence to interdependence, and vice versa, within the same individual. In one study, Trafimow, Triandis and Goto (1991) primed American participants with the Sumerian Warrior Story task. The story told of a warrior, Sostoras, who had to select a new general for the war. In the independent priming condition, Sostoras selected the new general because of his personal attributes and the advantages it would bring to Sostoras upon winning the war. While in the interdependent priming condition, the new general was selected due to his familial relations to Sostoras as well as the benefits it would bring to their family upon winning. After reading one of the texts, participants completed the Twenty Statement Test (Cousins, 1989; Kuhn & McParland, 1954) which was scored depending on the content of the statement following "I am". The content of the statements was categorised. Results showed that participants who received independent priming made more independent responses (e.g. statements about personal characteristics) than those who received interdependent priming. Similarly, those who received interdependent priming made more interdependent responses (i.e. statements about group affiliations) than those who received independent priming.

In another study, Brewer and Gardner (1996) primed Caucasian American participants with word search tasks before completing the Twenty Statement Test. Participants were instructed to circle all the pronouns while reading a short text that contained either interdependent pronouns such as "we" or other pronouns such as "they" or "it". The responses to the Twenty Statement Test after priming showed significantly more interdependent self-descriptions that describe group membership than the other groups. Kuhnen and Oyserman (2002) also showed that word search tasks with interdependent pronouns (we, our, us) induced context-sensitive processing, while independent pronouns (I, my me) induced context-insensitive processing. This

suggested that the shift between independent and interdependent self can be achieved through simple tasks.

Additional evidence comes from neuroimaging research. For instance, Chiao and colleagues (2010) scanned bicultural participants using functional magnetic resonance imaging (fMRI) as they completed trait judgment tasks after independent or interdependent priming. Each cultural prime consisted of the Sumerian Warrior Story (mentioned above) and a modified version of the Similarities and Differences with Family and Friends (SDFF) task (Trafimow et al., 1991). In the SDFF task, the independent priming task asked participants to think about what makes them different from their family and friends, then write a short essay on what they expect themselves to do for 8 minutes. For the interdependent priming task, the participants were instructed to think about what they have in common with their family and friends, and to write the essay on what their family and friends expect them to do. Half the participants were primed with independent culture, and the other half with interdependent culture. During the task, two types of self-judgements were made – a general self-task (e.g. in general does this sentence describe you?) and contextual self-task (e.g. does this sentence describe you when you are talking to your mother?). A font judgment task was used as control (e.g. is this sentence written in italics?). Neuroimaging results showed greater activations in the medial prefrontal cortex and posterior cingulate cortex for general rather than contextual self-descriptions after independent priming. In contrast, following interdependent priming, there were increased activations in the medial prefrontal cortex and posterior cingulate cortex for contextual rather than general self-descriptions. This demonstrated a shift between independent and interdependent frames of mind after the corresponding prime.

In addition, previous studies have demonstrated that cultural priming is most effective when the primed culture is incongruent with the participant's chronic or default culture (Gardner, Gabriel & Lee, 1999). Default culture refers to the prominent culture in which the participants have chronic access and experience to. In other words, independence is the default culture for westerners who identify the self as an autonomous individual, while interdependent is the default culture for East Asians who recognise the self through connections to family and friends.

Using participants from Hong Kong and the United States, Gardner and colleagues (Gardner, Gabriel & Lee, 1999) demonstrated the accessibility of different self-construals through congruent and incongruent cultural priming. Each participant received independent priming, interdependent priming, or no-priming (priming achieved with the Sumerian Warrior Story task) before completing a series of tasks that measured the endorsement of independent or interdependent behaviour. Participants from both cultures showed culturally consistent responses in both the no-priming and the congruent priming conditions. However, the incongruent priming condition elicited the opposite results. Participants from the US endorsed more interdependent values after interdependent priming, while Hong Kong participants endorsed more individualistic values after independent priming. These findings indicated that priming not only shifts self construal styles between independence and interdependence, it also produces the most prominent results when the cultural priming is incongruent with the default culture of the participant.

Neuroimaging studies also confirmed the effects of incongruent priming. Sui and colleagues (Sui, Hong, Liu, Humphreys & Han, 2012) investigated the modulation of neural activity after culturally incongruent priming. Participants were primed by word search tasks that either had no pronouns (neutral condition) or contained pronouns

such as “I, me, mine” (independent priming) or “we, us, our” (interdependent priming). Electroencephalography (EEG) was recorded as British and Chinese participants made judgments about the orientation of one’s own face and friend’s face. The anterior N2 component at 220-340ms was found to be modulated by incongruent cultural priming in both British and Chinese participants. After interdependent priming, British participants showed decreased N2 amplitude for the self face compared to the neutral condition, but not after independent priming. On the other hand, Chinese participants showed decreased activity for the friend face after independent priming but not after interdependent compared to the neutral condition. No changes were observed in the activity for the friend face after independent or interdependent priming in British participants, and no changes were observed for the self face after either cultural primes in Chinese participants. These results demonstrated that incongruent priming was more successful at modulating the self bias effect than congruent priming.

3.1.2. Objectives and hypotheses of the current study

Following these lines of research, the current study aimed to determine whether changes in social context could impact the self bias effect through cultural priming. Previously, most priming was achieved with one method, irrespective of implicit or explicit priming. The current study used implicit and explicit priming to test whether the same effects could be achieved with both methods. Additionally, the perceptual matching paradigm is designed to measure low-level processing. The use of different priming methods on low-level processing is an approach relatively few researchers have used. In this study, two experiments were conducted: Experiment 1 examined the effects of implicit priming on the self bias effect using word-search tasks (Colzato, de Bruijn, & Hommel, 2012; Sui et al., 2012); Experiment 2 examined the effects of

explicit priming on self bias using the SDFF task (Chiao et al., 2010; Trafimow et al., 1991). Following each condition, the participants would complete the perceptual matching task introduced in the previous chapter. The geometric shapes in the perceptual matching task eliminates any personal or social predispositions, which allowed parallel comparisons between the results from Experiment 1 and 2 despite methodological differences.

Based on prior findings, it was predicted that the incongruent cultural priming would produce the strongest results. Given that the key differentiation between independent and interdependent cultures is the way the concept of the self is perceived in relation to others (i.e. the self is an autonomous individual in independent values and the self is socially embedded among friends and family in interdependent values) (Gardner, Gabriel & Lee, 1999), it was predicted that the British participants in this study would show reduced self-bias towards friend associations after interdependent priming in contrast to independent priming. Thus, the hypotheses for the behavioural results were 1) for Experiment 1: implicit priming of the interdependent self would reduce the self bias relative to friend compared to after independent priming; 2) for Experiment 2: explicit priming would replicate the results from Experiment 1 and show a reduced self bias relative to friend after interdependent priming but not after independent priming.

This study investigated the modulation of social context on the self bias effect using implicit and explicit priming of independent and interdependent cues.

3.2. Experiment 1: Implicit priming

3.2.1. Method

3.2.1.1. Participants

Thirty-six[2] healthy volunteers (10 male, 26 female, 18 to 35 years of age, mean age ± standard deviation = 22.22 ± 4.51) took part in this study. All participants were Caucasian, right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment. The procedure used in this experiment was ethically approved by the University of Oxford Central University Research Ethics Committee.

3.2.1.2. Stimuli and materials

The stimuli and tasks were identical to those in Chapter 2 where participants learned to associate a shape with a label and then make judgments about whether the shape and label pair shown on the screen matched the associations previously learnt. For all participants, a white fixation cross was presented at the centre of the screen at 0.8 x 0.8 degrees of visual angle. One of three geometric shapes (triangle, square or circle) was presented above the fixation cross at 3.8 x 3.8 degrees of visual angle, and one of three labels (you, friend, or stranger) was presented below the fixation cross at 3.1/3.6 x 1.6 degrees of visual angle. The association of shapes with labels was counterbalanced across participants. The distance between the shape/word to the fixation cross was 3.5 degrees of visual angle. Stimuli were presented in a grey background on a 23-inch monitor (1920 X 1400 at 60 Hz). The programme was run on a PC using E-prime software (version 2.0). All stimuli were consistent with those used in the Sui, He, and Humphreys (2012) study.

[2] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 27 subjects were required to achieve *power* = .80, α = .05.

A questionnaire booklet was administered at the end of the experiment. This consisted of the same questionnaires from the previous chapter (Chapter 2), *see Appendices A.1 – A.6*.

3.2.1.3. Procedure

Each participant alternated between the word search task and the computer-based matching task six times before completing the study with a questionnaire booklet, *see Figure 6.* The six word search tasks consisted of two neutral texts (texts with no pronouns), two independent priming texts and two interdependent priming texts, *see Appendices B.1 – B.3 correspondingly*. Each priming text described a trip to a tourist destination using either no pronouns or with pronouns such as "I, me, myself" or "we, us, our". Participants were instructed to read each text and circle either target words or pronouns. In the neutral texts, participants were instructed to circle all instances of neutral words (e.g. *park, area, pyramid, giza, sphinx*), *see Appendix B.1*. The number of instances of target words was the same for both texts. In the independent and interdependent priming texts, participants were asked to circle all the pronouns (e.g. *I, my, me, mine* in the independent priming text and *we, our, ours, us* in the interdependent priming text), *see Appendices B.2 and B.3*. Participants received verbal instructions to read each text three times to make sure all the relevant words were circled. Following each priming text, participants subsequently performed a shape-label association task on the computer, *see Figure 6*.

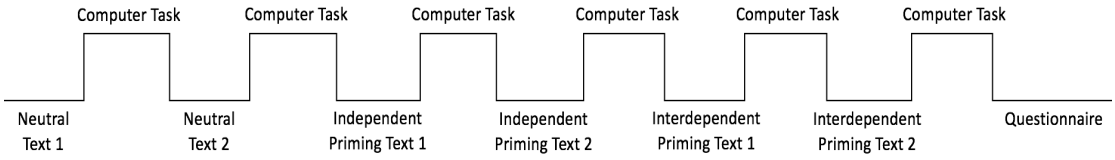


Figure 6. A schematic of the experiment procedure. The order of the independent and interdependent priming was counterbalanced between subjects.

Each perceptual matching task consisted of a training stage and a matching stage. In the training stage, participants learned to associate a shape with a label. For example, the triangle represents your best friend, the square represents you, and the circle represents a stranger. These learned association pairs remained the same throughout the six computer tasks for each participant. At this stage, the shapes were not presented on the screen. In the matching stage, the participants were asked to place both index fingers on one of two keys on the keyboard and made judgments about the shape and label pair shown on the screen. At the beginning of each trial, a fixation cross was presented at the centre of the screen for 2000ms, followed by a pair of shape and label above and below the fixation cross for 100ms. The shape and label pair either matched the associations previously learned in the training stage, or was a recombination of a shape with a label randomly generated by the computer task. Next, the screen remained blank for 1100ms, during which time the participants were expected to respond by pressing one of the two buttons as quickly and accurately as possible. Following a response, feedback (green "Correct" or red "Incorrect") was given on the screen for 500ms at the end of each trial. If no response was given within

the 1100ms timeframe, the feedback "Too Slow!" was displayed in yellow to prompt responses, *see Figure 7*. Feedback on overall accuracy was provided at the end of each block. The participants performed 9 practice trials and three blocks of 60 trials following each priming condition.

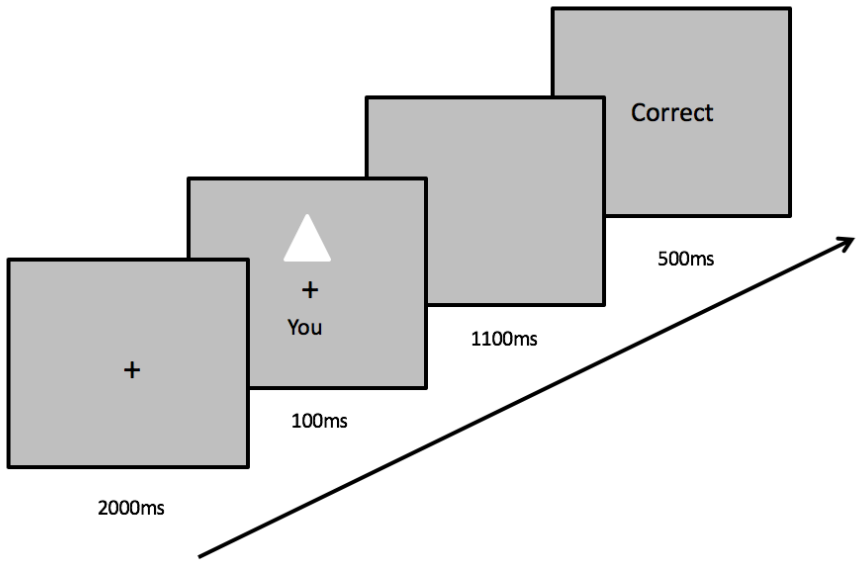


Figure 7. A trial procedure and an example of stimuli in the matching task.

Each participant performed two cycles of each priming consecutively. The experiment always started with the neutral tasks (see Chapter 2). Then, the participant either performed two cycles of the independent (circle pronouns such as 'I') or interdependent tasks (circle pronouns such as 'we') followed by two interdependent or independent tasks, *see Figure 6*. The order of independent and interdependent priming tasks was administered in a counter-balanced order across participants. After completing all priming and computer-based tasks, participants filled out a questionnaire booklet.

3.2.1.4. Experimental design and data analyses

Data analyses were performed and reported in three sections – RTs in match trials and d-prime. In the match trials, RTs from the neutral condition and priming conditions were analysed separately. As a separate dataset, the neutral condition was used to define bias groups by calculating the self bias relative to stranger (using stranger RT – self RT). A median split was used to separate the participants into low or high bias groups, which were then applied to the datasets with cultural priming. In the neutral condition, an ANOVA was performed with one within-subjects variable – shape-label association. The priming conditions was analysed with a 2 (priming condition: independent or interdependent) x 3 (shape-label association: self, friend, stranger) mixed design ANOVA with bias group (low or high bias) as the between-subjects variable. D-prime scores for the neutral and priming conditions were also analysed separately using the same method.

For each participant in each condition, mean RTs for the correct responses were calculated. Response times shorter than 200ms were excluded from the analysis as were RTs falling more than 3 standard deviations outside the mean for that condition. This eliminated less than 1% of the trials overall. Data from four participants were excluded from the analysis – two participants were due to low accuracy that were close to chance level, and two participants on the boundaries of the two bias groups were excluded to maximize the bias group effects.

3.2.2. Results

3.2.2.1. RTs in match trials

3.2.2.1.1. Neutral condition in match trials

The data from the neutral condition were analysed using one within-subjects variable – shape-label association (self, friend, or stranger). A repeated measures ANOVA on RTs revealed a significant main effect of shape-label association, $F(2, 62) = 49.03$, $p < .001$, $\eta^2 = .61$, *see Table 4*. Pairwise comparisons showed that RTs for the self association was significantly faster than both friend ($p < .001$) and stranger associations ($p < .001$), showing the effect of self bias. The RTs for friend association was also significantly faster than stranger association ($p < .01$).

Table 4. Mean RTs (ms) and SDs (in brackets) for match trials as a function of the association and priming in the Implicit experiment.

Association	Neutral	Independent priming	Interdependent priming
Self	633 (68)	613 (67)	609 (56)
Friend	695 (64)	653 (58)	647 (52)
Stranger	722 (56)	664 (72)	655 (57)

3.2.2.1.2. Priming conditions in match trials

The RTs from the independent and interdependent conditions were analysed with a mixed design ANOVA, using two within-subjects variables – priming condition (independent or interdependent) and shape-label association (self, friend, or stranger) – and one between-subjects variable – bias group (low or high bias), *see Table 4 and Table 5*. The analysis revealed a significant main effect of shape-label association, $F(2,$

60) = 36.78, $p < .001$, $\eta^2 = .55$, but not priming, $F(1, 30) = 1.54$, $p = .23$. Responses to the self association was significantly faster than both friend ($p < .001$) and stranger associations ($p < .001$), though no significant differences were found between friend and stranger associations ($p = .42$), *see Table 4*. A significant interaction was found between shape-label association and bias groups, $F(2, 60) = 3.81$, $p < .05$, $\eta^2 = .11$, but not between priming and bias group, $F(1, 30) = .00$, $p = .97$, nor between priming and shape-label association, $F(2, 60) = .30$, $p = .74$, *see Table 5*. Most importantly, the effects were qualified by a significant three-way interaction between priming condition, shape-label association and bias group, $F(2, 60) = 3.47$, $p < .05$, $\eta^2 = .10$, *see Table 5.*

Table 5. Mean RTs (ms) and SDs (in brackets) for match trials as a function of the association, priming and bias group in the Implicit experiment.

	Independent Priming		Interdependent Priming	
Association	Low Bias	High Bias	Low Bias	High Bias
Self	625 (64)	600 (68)	624 (52)	593 (57)
Friend	660 (70)	647 (45)	644 (50)	649 (55)
Stranger	658 (65)	669 (79)	656 (59)	653 (56)

Since the priming manipulation affected the relationship between self and important others, the three-way interaction between priming, shape-label association and bias group was decomposed using a mixed design ANOVA on the self-bias effect relative to friend (calculated using friend RT – self RT) after independent and interdependent priming. This analysis revealed a significant interaction between priming condition (independent or interdependent) and bias group (low or high bias), $F(1, 30) = 4.12$, $p = .05$, $\eta^2 = .12$, *see Table 5 and Figure 8*.

Paired samples t-tests found that interdependent priming reduced the self bias relative to friend in participants with low bias compared to independent priming, $t(15) = 2.24$, $p < .05$, $dz = .50$. However, this difference was not observed in participants with high bias after priming manipulation (interdependent vs. independent priming), $t(15) = -.94$, $p = .36$, $dz = .18$, *see Figure 8.* This indicated that individuals with low bias were more likely to be influenced by cultural context than those with high bias.

Independent samples t-tests on the self bias relative to friend revealed that the low bias group showed significantly lower self bias relative to friend than the high bias group after interdependent priming, $t(30) = -2.36$, $p < .05$, $dz = .78$, *see Figure 8*, but not after independent priming, $t(30) = -.87$, $p = .39$, $dz = .30$. This demonstrated that interdependent priming successfully decreased differences between self and friend associations among participants with low bias. These effects were consistent with previous research (Gardner et al., 1999).

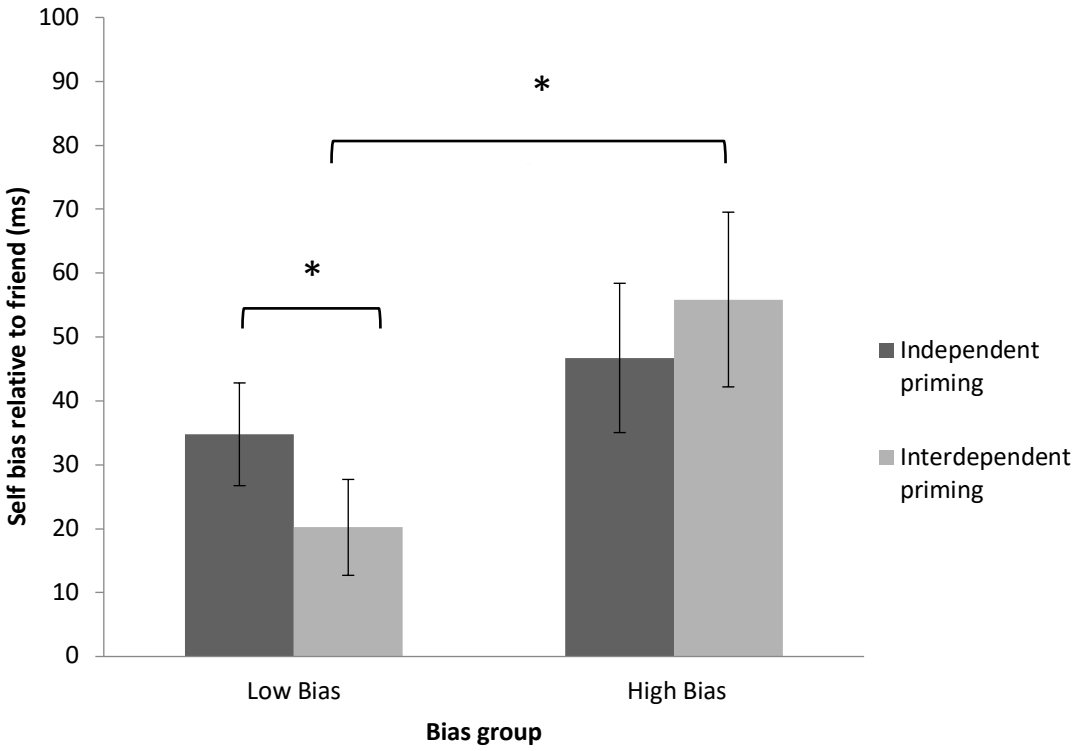


Figure 8. Decomposition of the significant interaction between priming, shape-label association and bias group using the self bias relative to friend (calculated friend RT – self RT) in the Implicit priming experiment. Mixed design ANOVA revealed a significant interaction between the priming and bias group, and the paired samples t-test revealed a significant difference of priming in the low bias group. Error bars represent one standard errors. Significant results are marked with "".*

3.2.2.2. D-prime

Using the Green and Swets (1966) formula, d-prime was calculated for each participant to determine participant sensitivity to correct and incorrect associations across both match and mismatch shape-based associations.

3.2.2.2.1. Neutral Condition

The data from the neutral condition were analysed using the shape-label association (self, friend, or stranger) as the one within-subjects variable, *see Table 6 for mean d-prime*. A repeated measures ANOVA on d-prime revealed a significant main effect of shape-label association, $F(2, 62) = 9.69$, $p < .001$, $\eta^2 = .24$, *see Table 6*. Pairwise comparisons showed that d-prime for the self-association was significantly higher than for friend ($p < .01$) and stranger associations ($p < .01$). D-prime for the friend association was not significantly different from the stranger association ($p = 1.00$).

Table 6. Mean d-prime and SDs (in brackets) as a function of association and priming in the Implicit experiment.

Associations	Neutral	Independent Priming	Interdependent Priming
Self	2.76 (0.83)	3.50 (1.17)	3.40 (1.05)
Friend	2.19 (0.90)	2.99 (0.95)	3.01 (0.91)
Stranger	2.15 (1.10)	3.02 (0.91)	3.18 (1.17)

3.2.2.2.2. Priming conditions

A mixed design ANOVA was used to analyse the data from the independent and interdependent priming conditions. The two within-subjects variables were priming condition and shape-label association, with bias group as a between-subjects factor. The analysis showed a significant main effect of shape-label association, $F(2, 60)= 10.82$, $p < .01$, $\eta^2 = .27$. D-prime score for the self association was significantly higher than friend ($p < .01$), and stranger associations ($p < .01$), but not significantly different between friend and stranger associations ($p = .96$). No main effect of priming was found, $F(1, 30)= .10$, $p = .76$. A significant interaction was found between shape-label association and bias group, $F(2, 60)= 5.59$, $p < .05$, $\eta^2 = .16$, *see Table 7*. Across priming conditions, the low bias group showed higher d-prime score for the self association than friend association, $t(15) = 2.85$, $p < .05$, $dz = .61$, but not stranger association, $t(15) = .83$, $p = .42$, $dz = .09$, and d-prime score for the stranger association was significantly higher than for the friend association, $t(15) = -2.97$, $p < .05$, $dz = .53$. The high bias group, on the other hand, showed higher d-prime score for the self association than for both friend, $t(15) = 2.94$, $p < .05$, $dz = .35$, and stranger associations, $t(15) = 4.46$, $p < .001$, $dz = .57$, but friend and stranger associations were not significantly different, $t(15) = 1.44$, $p = .17$, $dz = .20$. No interactions were found between priming and bias group, $F(1, 30)= 1.08$, $p = .31$, nor between priming and shape-label association, $F(2, 60)= 1.08$, $p = .35$. No three-way interaction was found between priming, shape-label association and bias group, $F(2, 60) = .15$, $p = .86$, *see Table 7*.

Table 7. Mean d-prime and SDs (in brackets) as a function of association, priming and bias group in the Implicit experiment.

	Independent Priming		Interdependent Priming	
Associations	Low Bias	High Bias	Low Bias	High Bias
Self	3.32 (1.17)	3.68 (1.17)	3.35 (1.03)	3.44 (1.10)
Friend	2.79 (0.59)	3.18 (1.20)	2.85 (0.62)	3.17 (1.14)
Stranger	3.13 (0.82)	2.92 (1.01)	3.36 (1.14)	3.00 (1.21)

3.2.2.3. Correlation analyses

Correlation analyses on the self bias effect and the questionnaire measures are reported in Chapter 7.

3.2.3. Discussion

3.2.3.1. Findings

Experiment 1 examined the effects of implicit priming on self and other processing in perceptual matching. The hypothesis for this experiment was that incongruent priming (i.e., interdependent priming) would be most effective in British participants, and that priming of the interdependent self would decrease the difference in response time between self and friend in contrast to independent priming. Results of this experiment revealed that in people with low bias, a reduced self bias relative to friend was observed after interdependent priming compared to after independent priming. Moreover, this reduced self-bias relative to friend was only observed in

participants with low bias but not in those with high bias. The pattern of these results was consistent with those found by Gardner and colleagues (1999).

This can be explained by individual differences in the magnitude of the self bias effect and that some people can shift between independent and interdependent self-construal styles more easily than others. Ellis and Boyce (2011) explain that neurobiological variation exists in sensitivity to contextual cues, which determines individual differences in one's openness to environmental influences. Similarly, people with lower or weaker bias may be more sensitive and susceptible to contextual signals than others. This finding confirmed our initial hypothesis that social context influences the concept of the self, and consequently the effects of self-bias in perception can be modulated through contextual cues such as independent and interdependent priming. Also consistent with our hypothesis, the effects of priming on behaviour was most substantial when incongruent with the default culture of the participant. In this case, interdependent priming successfully reduced self bias in perceptual matching in some British participants.

D-prime scores showed a robust self bias effect in the significantly higher sensitivity to self associations than for friend and stranger associations. This was found in both the neutral condition and the two priming conditions. Interestingly, across the priming conditions, participants demonstrated different degrees of sensitivity to friend association between the low and high bias groups. In the low bias group, sensitivity for friend was lower than sensitivity for self and stranger. This may be explained by sensitivity to the two extreme opposites of personal perception (self vs stranger). In contrast, the high bias group were more sensitivities to self related stimuli than other stimuli, which was consistent with the idea that some people may demonstrate stronger self bias than others.

3.2.3.2. Limitations

A limitation for this experiment was that the neutral condition always took place at the beginning of the experiment and only the order of the independent and interdependent priming was counterbalanced. This may have resulted in a learning curve that only took place in the neutral condition, which may skew the results slightly. Ideally, the order of all three conditions should be counterbalanced to avoid any confounding variables. This was taken into consideration in Experiment 2, where all three conditions were counterbalanced.

3.3. Experiment 2: Explicit priming

3.3.1 Method

3.3.1.1. Participants

Thirty-six[3] healthy volunteers (11 male, 25 female, 18 to 32 years of age, mean age ± standard deviation = 21.61 ± 3.51) took part in this study. All participants were Caucasian, right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment. The procedure used in this experiment was ethically approved by the University of Oxford Central University Research Ethics Committee.

3.3.1.2. Stimuli and materials

Stimuli and materials used in this study were the same as the Implicit Priming experiment.

[3] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 27 subjects were required to achieve *power* = .80, α = .05.

3.3.1.3. Procedure

Each participant alternated between an essay priming task and the computer-based perceptual matching task three times. A questionnaire booklet was completed at the end of the experiment, *see Figure 9*. The essay priming task was a modification of the SDFF task used in Chiao et al. (2010). Participants were asked to think about a question for two minutes, and then write a short essay in response to another question for eight minutes. In the neutral condition, participants were given the instructions "*For the next two minutes, please think of what items are in your bedroom*", and then to write a short essay in response to the question "*what do you have in your bedroom?*" For the independent priming conditions, participants were asked to think about "*what makes you unique from your friends and family"*, and write an essay in response to "*what do you expect yourself to do?*" For the interdependent priming condition, participants were asked to think about "*what you have in common with your friends and family"*, and to write about "*what do your friends and family expect you to do?*" Participants were instructed to write as much as they can and be as detailed as they can for the essays. Following each priming task, participants performed a perceptual matching task on the computer, *see Figure 9*.

The perceptual matching task was the same as the one used in the implicit priming experiment. To keep the number of trials the same between the two experiments, participants performed six blocks of 60 trials instead of three blocks after each priming task. Unlike the implicit priming experiment, the order of the three priming conditions was administered in a counter-balanced order across participants. Each participant completed a questionnaire booklet at the end of the experiment.

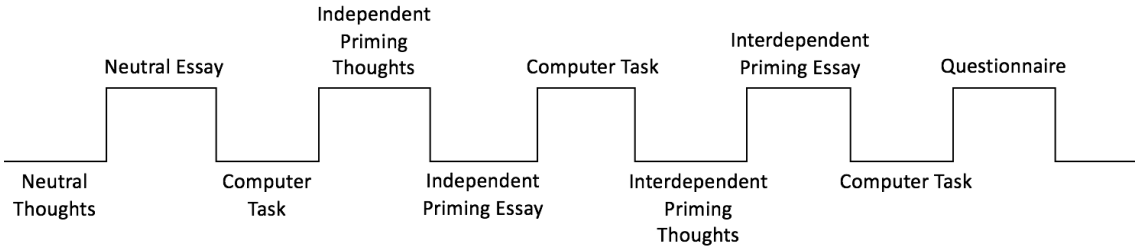


Figure 9. A schematic of the experiment procedure. The order of all three conditions was counterbalanced between subjects.

3.3.1.4. Experimental design and data analyses

Data analyses were performed and organised in the same way as Experiment 1. Response times shorter than 200ms and RTs falling more than 3 standard deviations outside the mean for that condition were excluded from the analysis, which eliminated less than 1% of the overall trials. Again, self bias relative to stranger (calculated using stranger RTs – self RTs) from the Neutral condition was used to assign participants into low or high bias groups. Data from four participants on the boundaries of the two bias groups were excluded to maximize the bias group effects.

3.3.2. Results

3.3.2.1. RTs in match trials

3.3.2.1.1. Neutral conditions in match trials

Data from the neutral condition were analysed using one within-subjects variable – shape-label association (self, friend, stranger). A repeated measures ANOVA on correct RTs revealed a significant main effect of shape-label association, $F(2, 62) = 38.84$, $p < .001$, $\eta^2 = .56$, *see Table 8*. The RTs for the self associations were

significantly faster than for friend ($p < .001$), and stranger associations ($p < .001$). However, RTs for the friend association was not significantly different to those of the stranger association ($p = .22$).

Table 8. Mean RTs and SD (in brackets) for match trials as a function of association and priming in the Explicit priming experiment.

Associations	Neutral	Independent Priming	Interdependent Priming
Self	608 (64)	611 (58)	620 (71)
Friend	660 (74)	664 (64)	665 (71)
Stranger	671 (79)	679 (68)	680 (78)

3.3.2.1.2. Priming conditions in match trials

Data on RTs from the independent and interdependent priming conditions were analysed together using a mixed design ANOVA. This included priming (independent or interdependent) and shape-label association (friend, self, or stranger) as the two within-subjects variables, and bias group (low or high bias) as the between-subjects variable, *see Table 9*. The analysis revealed a significant main effect of shape-label association, $F(2, 60) = 67.62$, $p < .001$, $\eta^2 = .69$. The RTs for the self association were significant faster than friend ($p < .001$) and stranger associations ($p < .001$). Friend association also elicited significantly faster RTs than stranger association ($p < .001$). No main effect of priming was found, $F(1, 30) = .11$, $p = .74$. A significant interaction was

found between shape-label association and bias groups, $F(2, 60) = 9.50$, $p < .001$, $\eta^2 = .24$, *see Table 9*. No interactions were found between priming and bias group, $F(1, 30) = .00$, $p = .98$, nor between priming and shape-label association, $F(2, 60) = .64$, $p = .53$. No significant three-way interaction was found between priming condition, shape-label association and bias group, $F(2, 60) = .96$, $p = .39$.

Table 9. Mean RTs (SD in brackets) for match trials as a function of the shape-label association, priming, and bias group in the Explicit experiment.

	Independent Priming		Interdependent Priming	
Match RTs	Low Bias	High Bias	Low Bias	High Bias
Self	619 (59)	603 (57)	635 (81)	605 (59)
Friend	667 (75)	661 (55)	661 (79)	668 (65)
Stranger	666 (71)	692 (65)	667 (84)	694 (71)

Although no significant three-way interaction was found between priming, shape-label association and bias group, given the results from Experiment 1, the effects of priming were examined using a priori t-tests. Paired samples t-test revealed that participants in the low bias group demonstrated significantly lower self-bias relative to friend after interdependent priming than after independent priming, $t(15) = 2.26$, $p < .05$, $dz = .54$, *see Figure 10*. The effect was not observed in participants in the high bias group after priming, $t(15) = -.42$, $p = .68$, $dz = .13$.

Independent samples t-test on the self bias relative to friend revealed that after interdependent priming, the low bias group showed significantly smaller bias than the high bias group, $t(30) = -2.94$, $p < .01$, $dz = .94$, *see Figure 10*. However, after independent priming, no difference between the low bias group and the high bias group was found, $t(30) = -.74$, $p = .47$, $dz = .26$. Again, interdependent priming successfully modulated the self bias relative to friend in participants with low bias. These results replicated the result from Experiment 1.

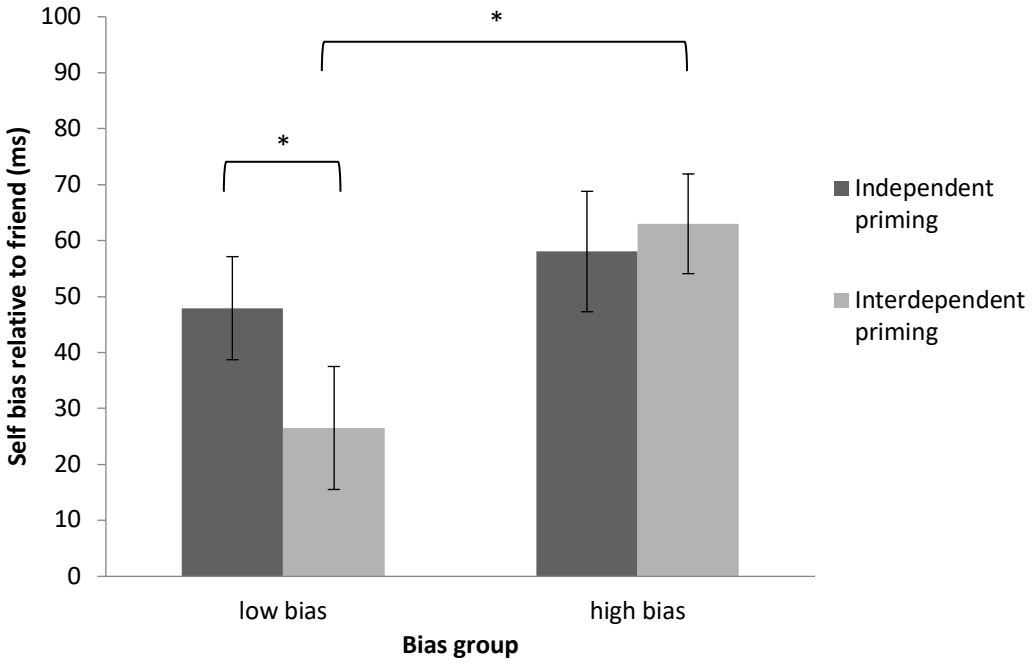


Figure 10. Decomposition of the significant interaction between priming, shape-label association and bias group using the self bias relative to friend (calculated friend RT – self RT) in the Explicit priming experiment. Mixed design ANOVA revealed a significant interaction between priming and bias group, and the paired samples t-test revealed a significant difference of priming in the low bias group. Significant results are marked with "".*

3.3.2.2. D-prime

3.3.2.2.1. Neutral condition

D-prime scores from the neutral condition were analysed with shape-label association (self, friend, or stranger) as the within-subjects variable. A repeated measures ANOVA revealed a significant main effect of shape-label association, $F(2, 62) = 5.37$, $p < .01$, $\eta^2 = .15$, *see Table 10*. Pairwise comparisons showed that d-prime score for the self association were significantly higher than for friend associations ($p < .01$) but not for stranger associations ($p = .20$). D-prime scores for friend and stranger associations were not significantly different ($p = .70$).

Table 10. Mean d-prime scores and SD (in brackets) as a function of association and priming in the Explicit Priming experiment.

Association	Neutral	Independent Priming	Interdependent Priming
Self	3.08 (1.07)	3.30 (1.25)	3.23 (1.13)
Friend	2.55 (1.08)	2.60 (1.12)	2.62 (0.95)
Stranger	2.76 (1.42)	2.84 (1.16)	2.70 (0.98)

3.3.2.2.2. Priming conditions

A mixed design ANOVA was used to analyse the d-prime scores from the independent and interdependent priming conditions. This was done using priming condition (independent or interdependent) and shape association (self, friend, or

stranger) as the two within-subjects variables, and bias group (low or high bias) as a between-subjects factor. The analysis revealed a significant main effect of shape-label association, $F(2, 60)= 16.18$, $p < .001$, $\eta^2 = .35$, *see Table 11*. Pairwise comparisons showed that d-prime score for the self association was significantly higher than for friend ($p < .001$) and stranger associations ($p < .001$). D-prime scores for friend association were not significantly different from stranger association ($p = .37$). No priming effect was found, $F(1, 30) = .10$, $p = .76$. No significant interactions were found between priming and bias group, $F(1, 30) = .75$, $p = .39$, between shape-label association and bias group, $F(2, 60) = .28$, $p = .76$, , nor between priming and shape-label association, $F(2, 60) = .34$, $p = .71$. There was no significant three-way interaction between priming, shape-label association and bias group, $F(2, 60) = .36$, $p = .70$.

Table 11. Mean d-prime scores and SD (in brackets) as a function of association, priming and bias group in the Explicit Priming experiment.

	Independent Priming		Interdependent Priming	
Associations	Low Bias	High Bias	Low Bias	High Bias
Self	3.20 (1.04)	3.39 (1.46)	3.24 (1.28)	3.22 (1.01)
Friend	2.46 (0.95)	2.74 (1.29)	2.65 (0.92)	2.58 (1.01)
Stranger	2.74 (1.09)	2.95 (1.25)	2.86 (0.84)	2.54 (1.12)

3.3.2.3. Correlation analyses

Correlation analyses on the self bias effect and the questionnaire measures are reported in Chapter 7.

3.3.3. Discussion

3.3.3.1. Findings

Experiment 2 employed an explicit priming method to investigate the effect of social context on modulating the self-bias effect relative to friend. The hypothesis was that the self bias relative to friend would be significantly reduced after interdependent priming compared to after independent priming, which would replicate the results from Experiment 1. Results from this experiment revealed that people with initial low bias showed reduced self bias relative to friend after interdependent priming than after independent priming. Additionally, the RT differences between self and friend were significantly reduced after interdependent priming in the low bias group compared with those in the high bias group. These results were consistent with the results from Experiment 1. The low and high bias groups reflected individual differences in the magnitude of the self bias effect, which suggested that some people were more receptive to contextual cues than others. As a result, interdependent priming was more successful at facilitating the shift from one cultural framework to another in British participants with low bias.

D-prime scores for the self association consistently showed greater sensitivity than other associations. This was observed in the neutral condition, as well as across independent and interdependent priming conditions, demonstrating a robust self bias effect.

3.3.3.2. Limitations

One limitation for this experiment was the essay topic for the neutral condition. Given the within-subjects design of this experiment, it was important that all three conditions were carried out in the same procedure. However, the priming method adapted from the study by Chiao and colleagues (Chiao et al., 2010) only consisted of independent and interdependent priming. Thus, an essay topic was devised to shift one's focus from independent or interdependent experiences. It was decided that objects in one's bedroom would be more neutral because many items such as furniture are commonly found across cultures and typically do not carry cultural values. Personal items that carry sentimental value may also act as a reminder of one's self-construal style and default cultural experiences. Nevertheless, the essay question has not been tested before and it is unclear whether the topic was adequate as a neutral condition. Despite this, a priming effect was found in the low bias group based on the neutral condition, suggesting that the essay question devised for the neutral condition successfully identified low and high biased individuals.

3.4. General discussion

3.4.1. Findings and implications

While the previous chapter examined the self bias effect in a cross-culture context, this chapter investigated the effect of social context on the modulation of the self-bias effect within the same culture group. The current study used both implicit and explicit priming methods in combination with low-level perceptual matching task to study the dynamic changes in the concept of the self.

The initial prediction for this study was that both implicit and explicit priming of the incongruent culture in British participants (i.e. interdependent priming) would

reduce the self bias effect relative to friend. Current findings from both experiments revealed a weakened self bias relative to friend after interdependent priming in participants who showed initial low bias. The same effect, however, was not observed after independent priming, nor in participants with high bias. The consistency of the results between Experiment 1 and 2 demonstrated that both implicit and explicit cues could effectively modulate the self bias effect. However, these findings were a little different from the initial predictions in that high biased individuals remained unconvinced by the contextual primes. This phenomenon can be explained by individual differences in the magnitude of the self bias effect. Some people may be more sensitive to contextual cues than others. Alternatively, the situational primes may be a weak simulation of real-life contexts and thus have difficulty eliciting the same responses from all participants. Despite this, the same modulating effect on self bias was observed through implicit and explicit priming in participants with weaker bias.

3.4.2. Significance of this study

Findings from this study were consistent with previous research that different self-construal styles can be accessed through cultural priming. Although previous research has shown that access to both self-construals can be achieved in bicultural participants such as Hong Kong Chinese (e.g. Hong, Morris, Chiu, & Benet-Martinez, 2000) and Asian Americans (e.g. Fong et al., 2014), findings from this study further confirmed the modulation of social context on the self bias effect in monocultural participants.

The current study contributes to existing research in important ways. First, the shape-label association paradigm allowed direct comparisons between the effectiveness of implicit and explicit priming methods. The geometric shapes eliminated confounding

variables such as familiarity of the stimuli and any pre-existing personal or social-significance of the stimuli. As a result, the main difference between Experiment 1 and Experiment 2 were the priming methods. Hence, the consistency of the result patterns from the two experiments indicated that both implicit and explicit cues can effectively modulate self bias.

Second, individual differences were identified in the magnitude of the self bias effect. Results from both experiments found that interdependent priming exclusively reduced self bias in participants with low bias. This means that some individuals have stronger self bias than others. Thus, it is important to be aware that individual differences exist in the sensitivity to social contexts such as independent and interdependent frames of mind.

3.4.3. Limitations and future research

One limitation of this study (which applies to both Experiment 1 and 2) is that it is unclear how long priming effects can last and thus carryover effects may influence the subsequent task. For example, the questionnaires were administered at the end of each session rather than the beginning. If the priming effects can last for a long time, it may carry over to the questionnaire which was designed to measure the default self-construal. The questionnaires might have been completed at the beginning of each session instead to avoid any lasting effect from the latest priming task. There may also be carryover effects between primes, in which a previous independent prime could dampen the effects of a subsequent interdependent prime or vice versa. Precautions such as timed breaks should be taken in between different primes to ensure that no effects were carried over. Another limitation is that the volunteers from this study were drawn from university students who may have a higher level of education and come

from a higher socioeconomic background than the general population. Thus, the generalisability of the findings may be limited due to different cultural values (Henrich, Hein & Norenzayan, 2010).

Future studies may consider the investigation of the neural responses of the shift between self-construal styles through cultural priming. For example, Lin, Lin and Han (2008) demonstrated the modulating effect of cultural priming on the early visual P1 component in ERP, which is associated with local/global attentional resources. After independent or interdependent priming, Chinese participants were asked to discriminate local/global letters. Findings indicated enlarged P1 amplitudes to local than global targets after independent priming and reduced P1 amplitudes to local than global targets after interdependent priming in the occipital region. Based on these results, it is expected that event-related potentials would further current understanding of the dynamic access to independent or interdependent self. Incorporating ERP into the perceptual matching task will shed light on the electrophysiological responses to self-related cues.

In conclusion, this chapter aimed to understand the impact of social context on the self bias effect. The self is a complex and dynamic concept that is constantly evolving in response to environmental cues. Although independent self-construal is considered a prominent framework for British participants, contextual cues can manipulate the way self-relevant information is processed by accessing the interdependent self. Through cultural priming, the current study has demonstrated that people adapt to specific situations by alternating between independent and interdependent frames of mind and that the self-bias effect can be modulated by contextual prompts.

Chapter 4

The influence of maternal sensitivity and mother-infant attachment upon the self bias effect

Abstract

Previously, a robust self bias effect was observed in the processing of self-related information (see Chapter 2 and 3). However, this bias can be modulated by one's major life experience, for instance, the transition into motherhood. Such transformations take place physically by forming attachments to the infant and developing sensitivity to infant cues (Sullivan, et al., 2011). Maternal sensitivity refers to the mother's awareness and response to infant cues (Ainsworth, Blehar, Waters, & Wall, 1978). The aim of this study was to examine whether maternal sensitivity to infant cues could surpass the self-bias effect. Using the shape-label association paradigm, the current chapter examined the self-bias effect in participants (i.e. mothers) with five associations (infant, self, mother, friend and stranger). Results revealed faster responses and higher sensitivity to the self association than associations with mother, friend and stranger – the presence of self-bias effect. However, the striking result was the significantly faster RTs and higher d-prime in response to the baby association rather than the self association, reflecting a reverse of the self bias effect. This is the first ever evidence showing an obvious loss of self bias in healthy population. Faster and more accurate responses to family members over non-family members were also observed. In addition, a negative correlation was found between the quality of mother-infant attachment and the self bias relative to strangers, which suggested that stronger mother-infant attachment predicted weaker self bias towards strangers. These results indicated that the self is a dynamic concept that can be modulated by life experiences such as becoming a mother.

Keywords: mother infant attachment, self-bias, maternal sensitivity

4.1. Introduction

The last two chapters investigated the effects of the social environment on self-perception. Chapter 2 examined the differences in self biases between Eastern and Western cultural backgrounds by focusing on a key contrast between Hong Kong and British participants. Due to collectivist views of the self, Hong Kong participants were more inclined to a weaker self bias in perceptual matching than British participants. Chapter 3 investigated the modulation of the self bias effect within the same social environment through cultural priming. British participants were tested under three conditions – no priming, independent priming, and interdependent priming. It was found that people with low self bias were more responsive to interdependent priming, which resulted in reduced self bias relative to friend when compared to after independent priming. These results demonstrated that social context is a key factor in determining how the self is perceived – whether the self is an autonomous individual or connected with family and friends. Based on these findings, this chapter aimed to explore how other life experiences can impact the concept of the self. Specifically, the transition into motherhood is one of the most important development in a woman's life and this chapter studied the changes in the self bias effect as a result of the transition into parenthood from a woman's perspective.

4.1.1. Motherhood changes a woman's self-concept

Previous chapters (see Chapters 2 and 3) have demonstrated a very robust bias towards self processing. However, there may be exceptions to this self bias effect especially during important life experiences. The transition into parenthood is a major development in anyone's life and becoming a mother can have significant impact on the concept of the self by motivating a bias towards the infant. This transition takes place,

first, by reshaping a woman's self identity during pregnancy to achieve an ideal maternal self, then, by building maternal sensitivity and attachment to the infant postpartum through interactions such as breastfeeding.

4.1.1.1. Self identity evolves into the maternal self

During pregnancy, the self identity undergoes a transformation to attain the ideal maternal self. Mentally, this transition into motherhood requires changes in behaviours and responsibilities that restructures the self-concept (Barba & Selder, 1995). Mothers must adapt to the new reality while still maintaining the integrity of the self identity (Mercer, 2004). Rubin (1976) described the maternal role attainment process in the following stages: mimicry, role-play, fantasy, introjection-projection-rejection, and identity (as cited in Mercer, 2004). In other words, the pregnant woman observes and imitates the behaviour of other mothers, then either accepts or rejects certain behaviours as her own through role-play and fantasy, and finally constructs an ideal image of the self as a mother. The transformation is complete with the maternal self, which is constructed by integrating the ideal image of the self as a mother with the pre-pregnant self. Thus, self identity shifts to accommodate the behaviours and responsibilities of becoming a mother, and the self assumes maternal roles as a result. Next, postpartum interactions between the mother and infant builds mother-infant attachment and maternal sensitivity.

4.1.1.2 Building mother-infant attachment and maternal sensitivity postpartum

The need to form and maintain attachment between mother and infant is observed in both humans and other mammal species (Numan, Fleming, & Levy, 2006; Numan & Insel, 2003). It is an emotional connection that is dynamic and bidirectional

(Kennell & Klaus, 1998) in that the mother engages in maternal behaviour for provision of care whilst the behaviour of the infant motivates and elicits parental care (Sullivan, Perry, Sloan, Kleinhaus, & Burtchen, 2011). The two main functions of the mother-infant attachment are – first, to ensure that the infant receives enough care from the caregiver for survival; and second, the quality of the attachment is crucial to an infant's emotional and cognitive development (Sullivan et al., 2011).

The attachment between the mother and infant are established and maintained through underlying biological changes as well as postpartum interactions (Kinsley et al., 2008; Strathearn et al., 2009). The neuropeptide oxytocin is the foundation for the capacity to form close relationships such as the mother-infant attachment (Gimpl & Fahrenholz, 2001), and the attachment is expressed and defined through post-partum behaviours that emerge and intensify during interactions such as touch, proximity, gaze at the infant, "motherese" vocalizations, positive expression, and adaptation to infant cues (Feldman, Weller, Zagoory-Sharon & Levine, 2007). From an evolutionary perspective, this communication between the mother and infant is essential for offspring survival (Carter & Kevenerne, 2002; Young et al., 2015). The mother-infant attachment has typically been measured with questionnaires such as the Maternal Postnatal Attachment Scale (Condon & Corkindale, 1998).

A mother's sensitivity to infant cues may be a critical factor for the security of the mother-infant attachment (Bowlby, 1969). Maternal sensitivity refers to the mother's awareness and accurate interpretations of infant cues as well as the prompt and effective actions in response to the cues (Ainsworth, Blehar, Waters, & Wall, 1978). A sensitive mother is also characterised by her willingness to switch her attention in response to infant cue (Meins, Fernyhough, Fradley, & Tuckey, 2001). In other words, maternal sensitivity is a direct expression of the detection and response to

infant stimuli in real life. Maternal sensitivity is typically indexed by behavioural observations. For example, McElwain and Booth-LaForce (2006) coded interactions between mother-infant dyads at 6 months and 15 months and found greater sensitivity to distress by the mother at 6 months was correlated with increased odds of secure attachment. Sensitivity at 15 months, however, was not correlated with secure attachment. Secure attachment is characterised by a healthy bidirectional relationship where the caregiver is available and responsive to the infant's needs, and the infant feels confident and perceives the caregiver as a safe base (Ainsworth & Bell, 1970). Studies that enhanced maternal sensitivity to infant cues also demonstrated increased mother-infant attachment security (Bakermans-Kranenbur, van IJzendoorn, & Juffer, 2003). Thus, maternal sensitivity is particularly important in forming healthy attachment during early infancy when the infant is especially vulnerable.

Maternal sensitivity is also crucial to infants' cognitive development, and reduced sensitivity impedes such growth (Pederson, 1997). For example, Feldman, Eidelman and Rotenberg (2004) monitored maternal sensitivity and the development of 138 infants, including 23 sets of triplets, 23 sets of twins and 23 singletons. The families' interactions were observed postpartum at 3, 6 and 12 months, and cognitive assessment was carried out on each infant individually. Findings revealed that triplets received lower maternal sensitivity due to the mothers experiencing high parenting stress and difficulties in providing exclusive care to each child. The lowered maternal sensitivity across triplets impeded the infants' cognitive development such as perception, attention, categorisation and inhibitory control skills. The triplet that received the lowest maternal sensitivity demonstrated the worst performances. In contrast, parents of singleton infants experienced less parenting stress and showed higher maternal sensitivity, which resulted in improved infant development. Other

studies also found maternal sensitivity associated with the ability to accurately identify the mental state of the infants' behaviours and secure attachment (Koren-Karie, Oppenheim, Dolev, Sher, & Etzion-Carasso, 2002; Meins et al., 2001).

Maternal behaviours not only benefit the infant, but also improve the mother's welfare by reducing stress. Mezzacappa and Katkin (2002) compared the stress levels in breast-feeding and bottle-feeding mothers and found that breast-feeding mothers reported less stress than the bottle-feeding mothers. Mothers also reported decreased negative mood in association with breast-feeding, whilst a decrease in positive mood was associated with bottle-feeding (Mezzacappa & Katkin, 2002). Physical contact with the infant not only buffers negative mood and stress but also contribute to maternal sensitivity (Kim et al., 2011).

Maternal sensitivity is important because it is a reflection of cue detection and response in real life. Despite the robustness of the self bias effect, responses to stimuli of close others such as mother (i.e. grandmother of the infant) and close friend have demonstrated weaker self bias compared to strangers (see Chapter 3 and 5). This means that the magnitude of the self bias can fluctuate in response to important stimuli. For a parent, rapid and accurate response to infant cues is an adaptive behaviour that ensures offspring survival (Young et al., 2015). Such responses may be reflected through the perceptual matching task. Moreover, high maternal sensitivity may even trigger a bias towards infant stimuli.

4.1.2. Objectives and hypotheses of the current study

To test whether the development of maternal sensitivity in women could impact the self bias effect, the shape-label association paradigm from Sui, He, and Humphreys (2012) was adapted to include more associations. Five associations were used instead of

three, including infant, self (i.e. the mother), mother (i.e. the grandmother of the baby), best friend, and stranger. This spectrum of stimuli provides this study with the opportunity to examine the strength of the bias as the familiarity with the associated person decreases from very familiar to not familiar at all. Moreover, this could test whether familiarity was a driving factor in the self bias effect as the infant is a new addition to the family and familiarity with the infant was weaker than the self. This perceptual matching paradigm allows equal comparisons between each stimulus as the geometric shapes removes any personal significance associated with self-related information.

In addition, the relationship between mother-infant attachment and maternal sensitivity indexed by the self bias (in relation to the infant) was tested. The Maternal Postnatal Attachment Scale developed by Condon and Corkindale (1998) was used to measure the attachment between the mother and the infant. This scale consisted of three subscales – quality of attachment, absence of hostility, and pleasure in interaction. In particular, the quality of attachment subscale was a focus of this study because the level of attachment was expected to indicate a mother's sensitivity to infant cues. This subscale measured the mother's desire for close interaction with the infant and consisted of items that measure sadness at separation, time spent with the infant and feelings of pleasure with the infant.

Overall, the goal of this experiment was to investigate the impact of the development of maternal sensitivity on the self bias effect. The hypotheses were: 1) a reduction of the self bias effect in relation to infant stimuli was expected due to a natural need to provide maternal care. Specifically, faster RTs and higher perceptual sensitivity (*d'*) would be found in response to the infant stimuli compared with self stimuli. 2) significant correlations should be found between the Maternal Postnatal

Attachment Scale, especially the Quality of Attachment subscale, and the bias relative to infant.

Generally, previous research on the mother-infant relationship has taken on a more biological or developmental approach (e.g. Feldman,Weller, Zagoory-Sharon, & Levine, 2007; Strathearn, Fonagy, Amico, & Montague 2009). The novelty of this experiment lies in the indirect and objective approach to the study of the cognitive changes in information processing from a mother's perspective. It is possible that this is, to date, the first study of its kind. Thus, the current study would have introduced a new area of research in this field. Moreover, the introduction of the perceptual matching paradigm could potentially be used as a behavioural measure for maternal sensitivity. This would provide a novel approach to the study of maternal sensitivity. The combination of behavioural measures with previous measures of observations and questionnaires would provide current research with new perspectives on the study of maternal sensitivity.

4.2. Method

4.2.1. Participants

Thirty-one[4] healthy volunteers (mean age in years ± standard deviation = 33.26 ± 4.99) took part in this study. All participants were mothers who, on average, gave birth around 16 months ago (mean age of infant in months ± standard deviation = 15.71 ± 6.00) and had normal or corrected-to-normal vision. Data from one participant was excluded due to taking anti-depressant at the time of the experiment. Informed consent

[4] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 20 subjects were required to achieve *power* = .80, α = .05.

was obtained from all participants prior to the experiment. The procedure used in this experiment was ethically approved by the University of Oxford Central University Research Ethics Committee.

4.2.2. Stimuli and materials

During the computer task, a white fixation cross was presented at the centre of the screen at 0.8 x 0.8 degrees of visual angle. One of five geometric shapes (triangle, square, diamond, pentagon or circle) was presented above the fixation cross at 3.8 x 3.8 degrees of visual angle, and one of five labels (baby, you, mum, friend, or stranger) was presented below the fixation cross at 3.1/3.6 x 1.6 degrees of visual angle. The association of shapes with labels was counterbalanced across participants. The distance between the shape/word to the fixation cross was 3.5 degrees of visual angle. Stimuli were presented in a grey background on a 13-inch monitor (1600 x 900 at 60 Hz). The programme was run on a PC laptop using E-prime software (version 2.0).

Questionnaire measures included the Maternal Postnatal Attachment Scale (Condon, & Corkindale, 1998), *see Appendix A.7*, and the Personal Distance Questionnaire (Sui, & Humphreys, 2015), *see Appendix A.6*.

4.2.3. Procedure

First, the participants were asked to complete the questionnaire booklet and to give information about themselves, their baby, their mother, best friend, and to pick a stranger name from a list of female names. This information included name, age, frequency and time spent together, as well as a rating of their familiarity and closeness to that person.

Then, the participants completed the shape-label association task on a laptop. The goal of this computer task was to make judgments about whether the shape and label displayed on the screen was the correct associations or not. The association task consisted of a learning phase and a test phase. In the learning phase, the participants learned to associate each shape with a person. For example, “the triangle is your baby, the circle is you, the square is your mother, the diamond is your best friend, and the pentagon is the stranger”. Participants were instructed to place the right index and middle fingers on two keys on the keyboard and to respond, as quickly and accurately as possible, to the correct or incorrect associations displayed on the screen by pressing the corresponding key. A practice block of 20 trials consisting of correct or incorrect associations were administered to demonstrate the task and ensure that the participant understood the task. In the testing phase, a fixation cross was presented at the centre of the screen for 2000ms at the beginning of each trial, followed by a pairing of a shape and label above and below the fixation cross for 100ms. The shape and label (i.e., Baby, You, Mother, Friend, Stranger) presented were either correct associations previously learned in the learning phase, or was a recombination of a shape with a label randomly generated by the computer task. Next, the screen remained blank for 3000ms, awaiting participant response. After each response, feedback in the form of green “Correct” or red “Incorrect” was given on the screen for 500ms at the end of each trial. When no response was received within the given timeframe, the feedback “Too Slow!” was displayed in yellow to prompt faster responses, s*ee Figure 11*. Feedback on overall accuracy was provided at the end of each block. There was unlimited time to break in between blocks, and the correct associations were displayed during the break to reinforce participants’ memory. In total, participants performed 20 practice trials in the learning phase, and three blocks of 120 trials in the testing phase.

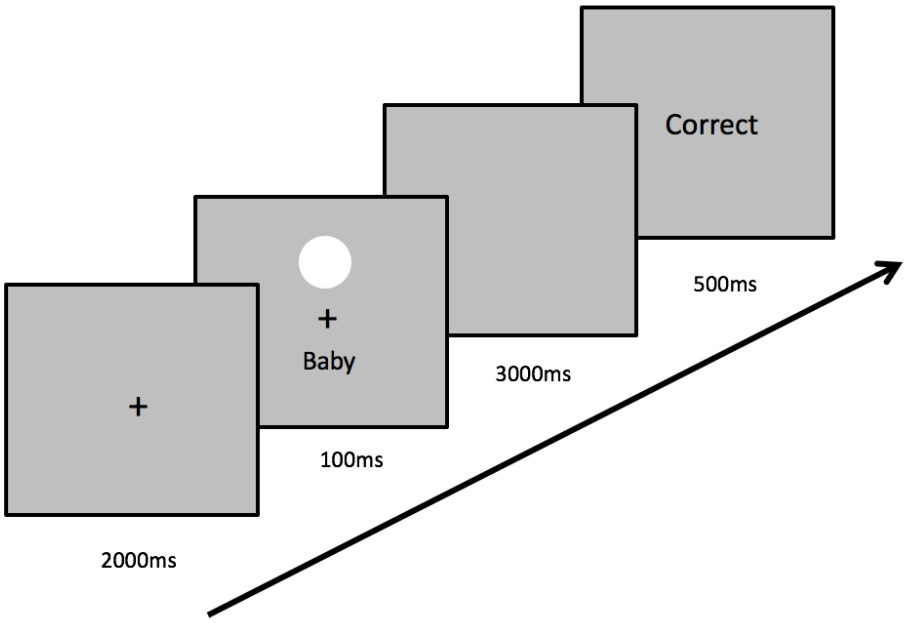


Figure 11. The trial procedure and an example of the stimuli for the computer task.

4.2.4. Experimental design and data analyses

Data were analysed and reported separately in two sections – RTs in match trials and d-prime. Mean correct RTs were calculated for each participant and each condition. Response times shorter than 200ms were excluded from the analysis. The data were cleaned by removing RTs that were more than 3 standard deviations outside the mean for each condition, which eliminated less than 1% of the trials overall. In each section, a repeated measures ANOVA was performed on the raw RTs with one within-subjects variable –shape-label association. Next, a repeated measures ANOVA was performed on the self bias, which was calculated using the differences in RTs between associations (self RTs – infant RTs, self RTs – mother RTs, self RTs – friend RTs, self RTs – stranger RTs). Correlation analyses were also performed on the self bias effect and the Maternal Postnatal Attachment Scale. Bonferroni correction was applied for multiple comparisons (Holm, 1979) in paired-samples t-tests.

4.3. Results

4.3.1. RTs in Match Trials

A repeated measures ANOVA with one within-subjects factor – the shape association (self, baby, mother, friend, or stranger) – was performed on the correct RTs. This revealed a significant main effect of shape-label association, $F(4, 120) = 22.24$, $p < .001$, $\eta^2 = .43$, *see Table 12 and Figure 12*. Paired samples t-test identified significant differences in the correct RTs between the shape-label associations. As predicted in the behavioural hypothesis, mean RTs for the baby association was significantly faster than the self association, $t(30) = 3.14$, $p = .004$, $dz = .54$, *see Table 13 and Figures 12*, which demonstrated the loss of the self bias in relation to the infant. There were also reliable self-bias effects compared to other associations, mean RTs for the self association were significantly faster than the mother association, $t(30) = -2.21$, $p = .035$, $dz = .38$, the friend association, $t(30) = -6.75$, $p < .001$, $dz = 1.08$, as well as the stranger association, $t(30) = -5.30$, $p < .001$, $dz = 1.08$. *For the presence of the self-bias effect, see Figures 12 and 13*.

Table 12. Mean RTs (ms) and SDs (in brackets) for match trials as a function of association.

Associations	Match RTs
Baby	682 (77)
Self	723 (75)
Mother	760 (109)
Friend	822 (102)
Stranger	834 (118)

Table 13. Mean RTs (ms) and SDs (in brackets) for match trials as a function of bias.

Biases	Match RTs
Baby vs. self	-40.86 (72)
Mother vs. self	37.10 (93)
Friend vs. self	98.78 (82)
Stranger vs. self	111.62 (117)

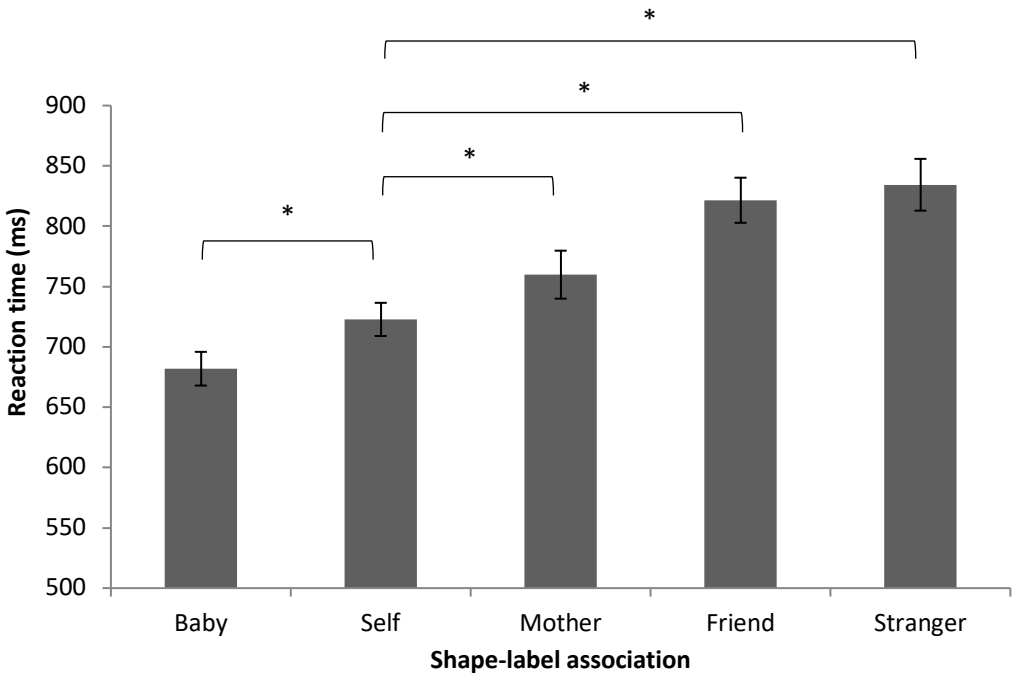


Figure 12. RTs on match trials as a function of shape association. Error bars represent one standard errors. Significant differences between associations are marked with ''. This graph demonstrated the comparison of other associations in relation to the self association.*

Next, the bias effects were calculated using baby RT – self RT, mother RT – self RT, friend RT – self RT and stranger RT – self RT. Using the self bias (relative to baby, relative to mother, relative to friend, and relative to stranger) as a within-subjects variable, a repeated measures ANOVA revealed a significant main effect of self bias, $F(3, 90) = 22.00$, $p < .001$, $\eta^2 = .42$. Paired samples t-test on the self bias found that the participants showed significantly stronger bias towards the baby association (i.e. infant bias) (baby RT – self RT) than the self bias relative to mother (mother RT – self RT), $t(30) = -4.03$, $p < .001$, $dz = .92$, friend (friend RT – self RT), $t(30) = -9.90$, $p < .001$, $dz = 1.81$, and stranger associations (stranger RT – self RT), $t(30) = -6.67$, $p < .001$, $dz = 1.49$, *see Figure 13*.

Further testing on the self bias effect also found an interesting divide between family and non-family members. The self bias relative to mother was significantly smaller than the self bias relative to friend, $t(30) = -3.09$, $p = .004$, $dz = .70$, and relative to stranger, $t(30) = -3.15$, $p = .004$, $dz = .69$, *see Figure 13*. However, the self bias relative to friend was not different from the self bias relative to stranger, $t(30) = -.53$, $p = .60$, $dz = .12$.

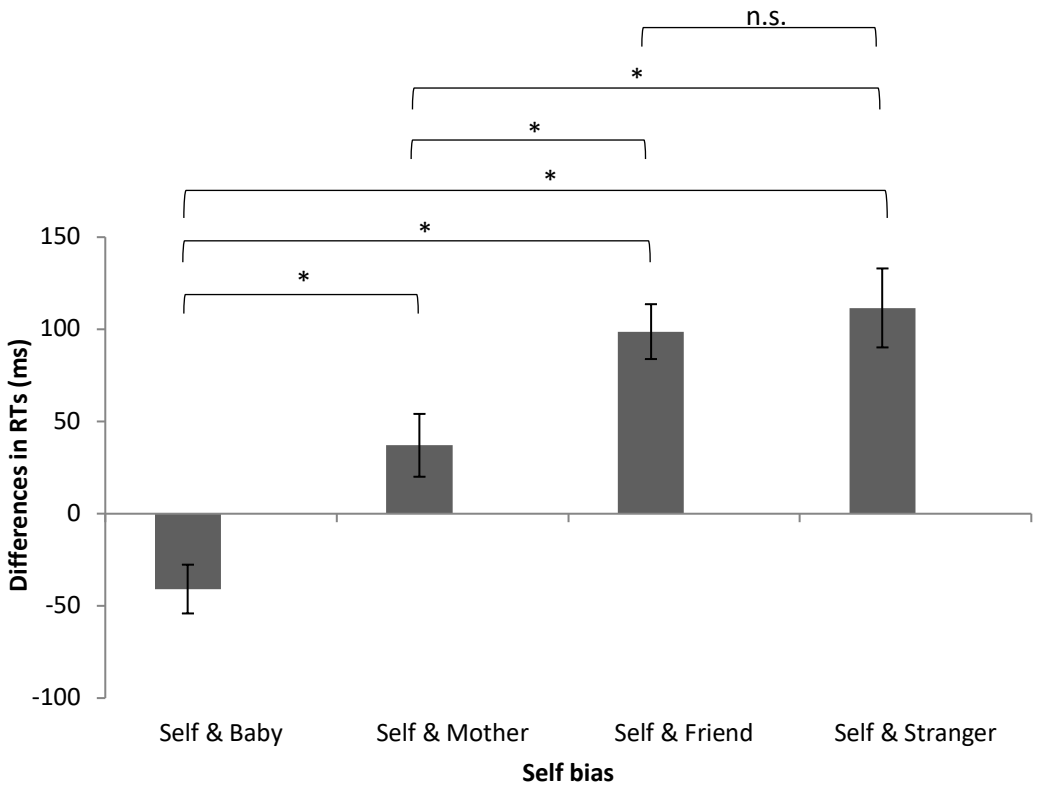


Figure 13. Self-biases in RTs for match trials as a function of person. Error bars represent one standard error. Significant differences between biases are marked with ''. This graph demonstrated the comparison between the self biases.*

4.3.2. D-prime

Using shape-label association as a within-subjects variable, a repeated measures ANOVA revealed a significant main effect of shape-label association, $F(4, 120) = 17.93$, $p < .001$, $\eta^2 = .37$, *see Table 14 and Figure 14.* Paired samples t-tests revealed that d-prime for the self association was significantly lower than the baby association, $t(30) = 2.46$, $p = .020$, $dz = .30$, but was significantly higher compared with friend, $t(30) = 4.88$, $p < .001$, $dz = .66$, and stranger associations, $t(30) = 5.56$, $p < .001$, $dz = .65$, *see Figure 14.* The mother association were not significantly different from the self association, $t(30) = .94$, $p = .354$, $dz = .15$, *see Figure 14*.

Table 14. Mean d-prime and SDs (in brackets) for both match trials and mismatch trials as a function of association.

Associations	D-prime
Baby	2.59 (1.22)
Self	2.23 (1.22)
Mother	2.06 (1.09)
Friend	1.52 (0.82)
Stranger	1.39 (1.37)

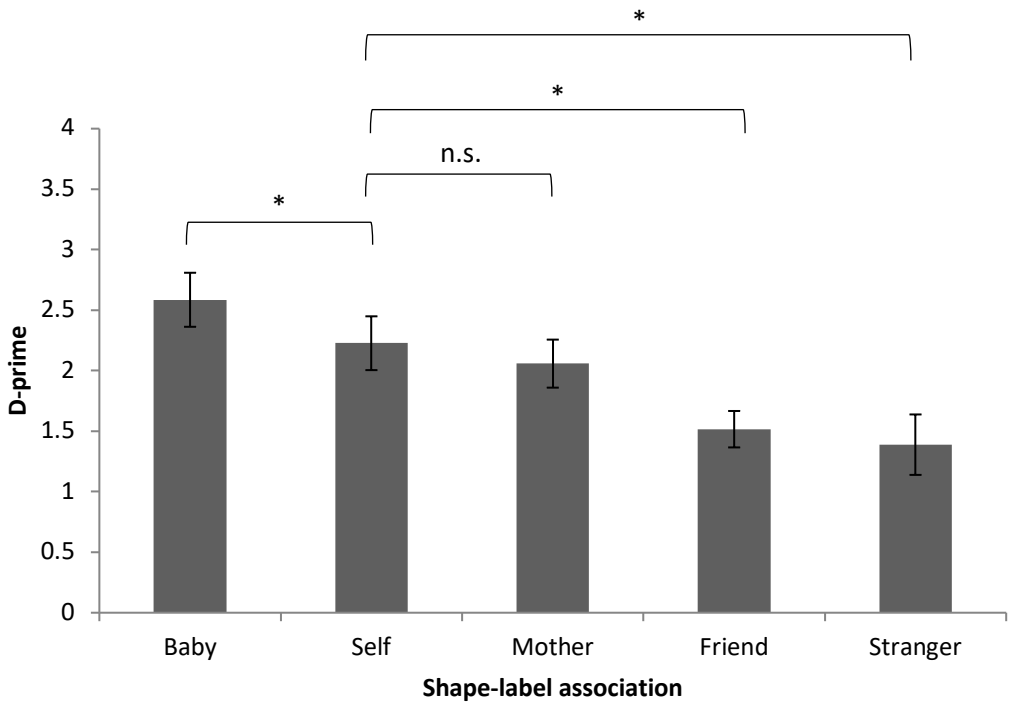


Figure 14. D-prime as a function of association. Error bars represent one standard error. Significant differences between associations are marked with ''.*

ANOVA on the self bias was calculated using the differential scores in d-prime between the self and other associations. A significant main effect of shape-label association was found, $F(3, 90) = 20.03$, $p < .001$, $\eta^2 = .40$, *see Figure 15.* Paired samples t-tests revealed that the d-prime for the self bias relative to infant was significantly higher than the other self biases in d-prime. The d-prime between the self bias relative to infant was higher than the d-prime self bias relative to mother, $t(30) = 2.57$, $p = .016$, $dz = .58$, the d-prime self bias relative to friend, $t(30) = 6.40$, $p < .001$, $dz = 1.32$, as well as the d-prime self bias relative to stranger, $t(30) = 6.99$, $p < .001$, $dz = 1.45$, *see Figure 15*.

Again, a divide between family and non-family members was observed. Paired samples t-tests showed that the self bias relative to mother was significantly smaller than the bias relative to friend, $t(30) = 3.55$, $p = .001$, $dz = .59$, as well as relative to stranger, $t(30) = 4.02$, $p < .001$, $dz = .72$. However, the self bias relative to friend was similar to the self bias relative to stranger, $t(30) = .74$, $p = .465$, $dz = .16$, *see Figure 15*.

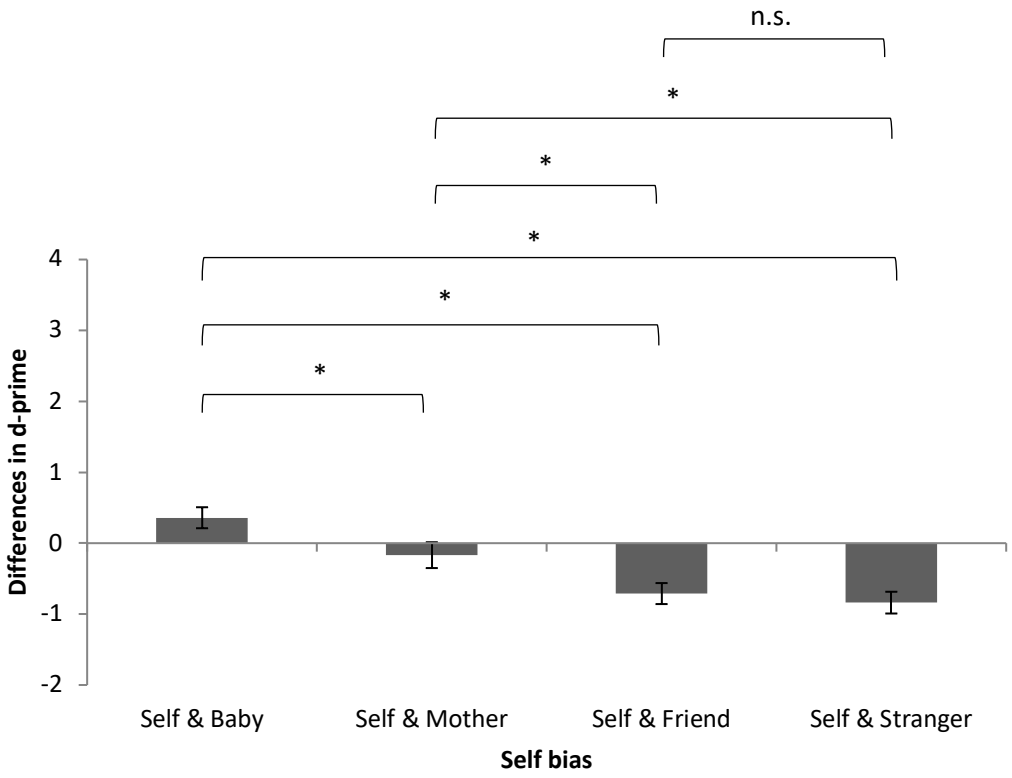


Figure 15. Self-biases in d-prime as a function of person. Error bars represent one standard error. Significant differences between biases are marked with ''.*

4.3.3. Correlation analysis

Correlation analyses were performed to investigate whether the self bias effect would correspond with the strength of the maternal-infant attachment. The relationship between the quality of attachment and the self bias effect in match RTs was examined. A significant negative correlation was found between the quality of attachment subscale and the self bias relative to strangers, Pearson's: $r = -.44$, $p < .05$, Spearman's rho: $r_s = -.48$, $p < .05$*, see Figure 16*. Further testing also revealed that this correlation was not driven by the data point on the far left. This means that mothers (i.e. the self) who shared better attachment with the infant demonstrated smaller response differences between the self and stranger stimuli. Interpretation for this result will be addressed in the discussion section below. No other correlations were found between attachment and the self bias effect (Pearson's: $-.31 < r < -.03$, $.09 < p < .89$, Spearman's rho: $-.29 < r_s < .05$, $.11 < p < .86$).

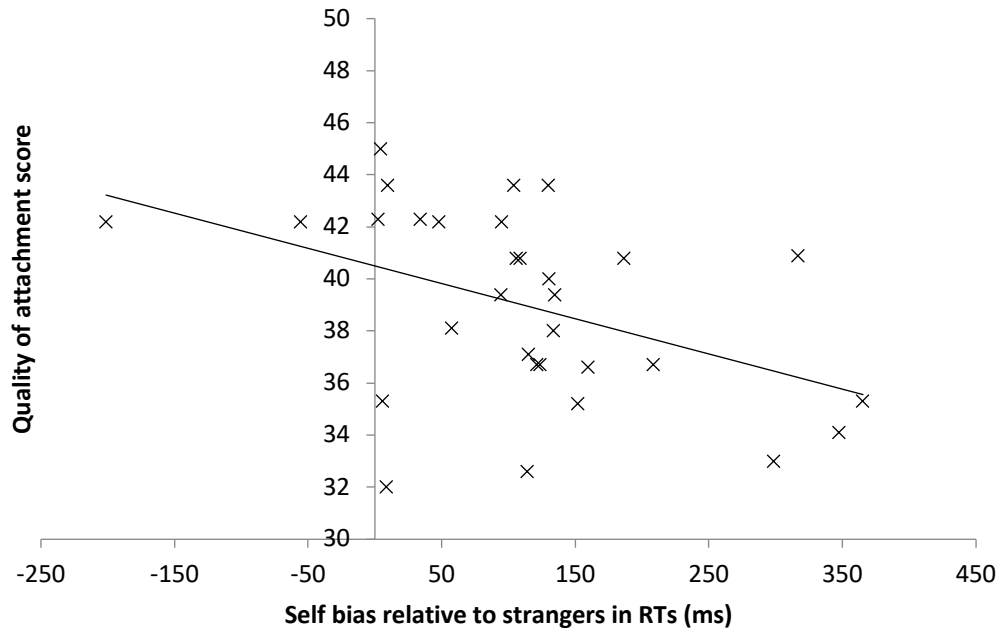


Figure 16. A negative correlation between the quality of attachment subscale score and the self bias relative to stranger in RTs.

Correlation analyses were also performed on the self bias (calculated using mother RT – self RT, friend RT – self RT, stranger RT – self RT) and the infant bias (calculated using baby RT – self RT) to determine whether the strength of the self bias could predict infant bias. Although initially a significant correlation was found between the infant bias and the self bias relative to friend using Pearson's ($r = .48$, $p < .05$), further testing revealed that this correlation was solely driven by an outlier. Upon removing the outlier, no significant correlations were found between the infant bias and the self bias relative to friend (Pearson's: $r = .31$, $p = .09$, Spearman's rho: $r_s = .15$, $p = .42$). In addition, no other correlations were found between the infant bias and self bias (Pearson's: $.17 < r < .31$, $.09 < p < .37$, Spearman's rho: $.10 < r_s < .24$, $.19 < p < .59$).

4.4. Discussion

This chapter examined the modulation of the self bias effect as a result of the transition into motherhood. The findings provided empirical evidence that the self bias effect can be modulated by major life development.

4.4.1. Findings and implications

The initial hypothesis was that the mother would demonstrate a loss of the self bias effect in relation to infant stimuli and process infant-related stimuli with faster responses (in RTs) and higher perceptual sensitivity (d-prime) than self-stimuli due to maternal sensitivity to infant cues.

The results were consistent with our initial hypothesis in that the loss of self bias in relation to the infant was observed in addition to the self bias seen in previous Chapters (Chapters 2 & 3). The reaction times to the infant-related stimuli were

significantly faster than those to the self stimuli, whilst responses to the self stimuli were significantly faster than those to the mother (i.e. grandmother), friend and stranger stimuli. This means that the robustness of the self bias effect was preserved despite the addition of the loss of self bias in relation to the infant. Similarly, the d-prime score for the infant association was greater than the d-prime score for the self association. Again, the self bias relative to friend and stranger in d-prime was intact. The only difference between the reaction time and d-prime results was that the perceptual sensitivity for the mother stimuli (i.e. grandmother) was similar to that of the self. Combining the reaction time and d-prime results, maternal sensitivity has resulted in the development of a new infant bias (relative to the self) in addition to the previously existing self bias (relative to other people).

This phenomenon may reflect the integration of the pre-pregnant self with the self as a mother. Past research suggested that the woman's concept of the self restructures as she assumes the role of a mother and take on responsibilities and behaviours that characterise motherhood (Barba & Selder, 1995). The prominent bias towards infant stimuli (faster RTs and higher d-prime) found in this study was a clear indication of the mothers' heightened sensitivity to infant-related cues. In addition, strong mother-infant attachment is predicted by high maternal sensitivity (Bowlby, 1969). The correlation between the quality of attachment and the self bias relative to stranger may also reflect high maternal sensitivity. This correlation may be explained in that mother-infant attachment is established and maintained by biological changes such as increased levels of oxytocin (Kinsley et al., 2008; Strathearn et al., 2009). Oxytocin is the foundation for forming close relationships (Gimpl & Fahrenholz, 2001). Moreover, increased oxytocin may also make strangers seem more trustworthy (Theodoridou, Rowe, Penton-Voak, & Rogers, 2009). Thus, the increased levels of

oxytocin in mothers may encourage more prosocial behaviour with strangers, which can be reflected in the decreased self bias relative to strangers. This result may be an indirect support for the link between maternal sensitivity and the self bias effect. Although, a correlation between the Quality of Attachment subscale and the bias relative to infant would provide strong evidence that maternal sensitivity can be linked to the self bias effect, no significant results were found between the two, contrary to the initial hypothesis. Current understanding of this subject is still limited and further studies are required to examine and explain the relationship between maternal sensitivity and the self bias effect.

Other than the loss of the self bias effect (in relation to infant stimuli), an unexpected behavioural result was also observed. A notable difference was found in the responses (both in RTs and d-prime) between the participants' mothers (i.e. grandmother of the infant) and best friend, but not between best friend and stranger. However, previous experiments on social associations (see chapters 2 and 3) demonstrated faster responses to friend but not to stranger. It appears that the spectrum of the associations in this particular experiment triggered a distinctive bias towards family members over non-family members.

The differentiation between mother and friend stimuli may be the outcome of an evolutionary need to differentiate kin from non-kin as a survival instinct when living in social groups (Hamilton, 1964; Platek & Kemp, 2009). Parental caregiving is crucial for survival of the offspring in humans and one critical caregiving task is the protection of one's children (Gilead & Liberman, 2014). This is particularly important when encountering other members of rival out-group since humans live in cooperative groups that compete over limited resources (e.g. Goodall, 1986). Gilead and Liberman (2014) examined outgroup bias as a result of the motivation to protect close kin. Using a series

of priming conditions and questionnaire measures, it was found across three studies that the activation of the caregiving system resulted in increased outgroup bias when outgroup posed a threat. This outgroup bias is reflected in this study through the family vs. non-family divide in the behavioural results.

This family divide was also supported by neuroimaging studies. For example, Han, Ma and Wang (2016) found neural correlates that reflected the self and family members in trait judgment tasks. In this study, married Chinese participants were scanned while completing a trait-judgment task in which they judged whether personality traits fittingly described family or non-family members. Shared activations of the medial prefrontal cortex were found for family members in comparison to non-family member. Therefore, when family members and non-family members are involved simultaneously in information processing, more attentional resources are distributed to family members first.

In conjunction with previous research, these findings provide a novel perspective in the investigation of the mother-infant relationship. It also identified major life developments such as motherhood as a modulating factor on the self bias effect.

4.4.2. Significance of this study

Findings from this study are significant in two ways. First, the results are the first demonstration of a reversed self-bias where stimuli-processing for another person has taken priority over the self in a healthy population. The significance of this finding is great as no other studies on the self have ever found a loss of the self bias effect relative to others. Past research has consistently demonstrated the robustness of the self

bias effect (e.g. Sui, He & Humphreys, 2012), which was also found in this study in the self bias relative to mother, friend and stranger, but the loss of the self-bias is a first. This finding is evidence that the self bias can be modulated by other factors such as major life developments like motherhood.

Second, the infant bias disproves the idea that self bias is the result of familiarity. It could be argued that the self bias effect is the result of familiarity with self-related stimuli (e.g. frequent use of self name, frequently seeing self face in the mirror etc.), but the infant-bias observed in this study suggests otherwise. The presence of the baby is very new and the familiarity with infant stimuli should be very low compared with self stimuli. Despite this, the mother was able to detect and react to infant cues significantly faster than self cues. This suggested that familiarity is not a contributing factor in explaining the self bias effect. In this particular context, the infant bias phenomenon proves to be consistent with the parental caregiving motivational system proposed by Hahn-Holbrook, Holbrook, and Haselton, (2011), which prompts responses from mothers to ensure offspring survival. Additionally, the intensive contact shared between mother and infant after birth may also contribute to the infant bias. Rarely do individuals share close contact constantly everyday for extended periods of time like a mother and a newborn infant. It is possible that this intimacy, along with the motivations to provide parental caregiving, together with other factors such as oxytocin levels all work together to promote a bias toward infant-related cues. Further research is required to better understand the bias toward infant cues.

4.4.3. Limitations and future research

A limitation to the current study is that lactation at the time of testing was not accounted for during data collection. Past research suggest links between breastfeeding

and better maternal sensitivity and secure attachment style. Kim and colleagues (Kim et la., 2011) found that breastfeeding mothers, compared with bottle-feeding mothers, showed greater activation in certain parts of the brain in response to infant cues. Breastfeeding mothers also demonstrated enhanced sensitivity in early infancy which may lead to greater odds of secure attachment (Britton, Britton, & Gronwaldt, 2006; Tharner et al., 2012). Thus, lactating mothers may show stronger sensitivity to infant-cues than non-lactating mothers. Future research should take factors like this into consideration to better control for confounds.

The current study examined the cognitive changes after childbirth through overt behavioural responses. However, modulation of the self bias effect due to maternal sensitivity may be the result of a complex interaction of multiple factors. For instance, the neuropeptide oxytocin may have contributed to maternal sensitivity on a biological level which is undetected by the current study. Oxytocin facilitates many maternal functions such as uterine contractions and milk ejection (Matthiesen, Ransjö-Arvidson, Nissen, & Uvnäs-Moberg, 2001). Levine, Zagoory-Sharon, Feldman and Weller (2007) found increased oxytocin levels from early to late pregnancy to positively correlate with high maternal-foetal attachment, suggesting that increased oxytocin levels are associated with increased prenatal bonding between mother and child. Bakermans-Kranenburg and van IJzendoorn (2008) also found evidence that parents with less efficient variants of the oxytonergic genes were less sensitive in responding to their children.

In line with these findings and the results from this study, further research can be conducted on another level to investigate the underlying factors to mother-infant bond. First, oxytocin plays an important role in maternal behaviour and the mother-infant bond during pregnancy as well as postpartum. However, it is unclear whether

oxytocin levels have influences on the magnitude of the self bias or infant bias in maternal perception. Strathearn and colleagues (2009) identified individual differences in maternal attachment and oxytocin levels. In particular, mothers with secure attachment showed increased release of peripheral oxytocin after interacting with the infant in comparison to mothers with insecure attachment. It is also unknown whether the level of oxytocin correlates with the strength of the infant-bias effect as a result of attachment quality. Further research is needed to determine the relationship between oxytocin production, quality of mother-infant attachment and the self bias effect.

Second, biological mothers experience biological changes during pregnancy, childbirth and lactation periods, which encourages the establishment of the mother-infant bond (Bick et al., 2013). Adoptive mothers, however, do not experience such changes. Thus, it is unclear the degree to which the non-biological mothers are sensitive to infant-cues and whether biological and non-biological infants would elicit different levels of the infant bias. Bick and Dozier (2010) examined the concentration of oxytocin in mothers after interactions with one's biological or non-biological children. Oxytocin analysis of 26 mothers revealed higher oxytocin levels after interaction with non-biological rather than biological children. The authors argued that this result was not driven by the differences in the quality of maternal behaviour but associated with the onset of the maternal interaction with non-biological infant. The authors also explained that the attempt to reduce stress levels experienced in response to non-biological infant may cause oxytocin levels to rise, because oxytocin was previously found to buffer stress (Heinrichs, Baumgartner, Kirschbaum, & Ehlert, 2003). If oxytocin encourages maternal behaviour and the quality of attachment is comparable between biological and non-biological mother-infant pairs, would we observe an infant-

bias in adoptive mothers too? It would also be interesting to compare the strength of the infant-bias in adoptive and biological mothers.

Third, parent-infant attachment not only occurs between mother and infant but also between father and infant. Relatively fewer research have looked at the father-infant relationship. Feldman and colleagues (Feldman, Gordon, Schneiderman, Weisman, & Zagoory-Sharon, 2010) recorded interactions of over one hundred mother and fathers with their infant. It was found that mothers engaged in more affectionate touch and fathers engaged in more stimulatory touch and that oxytocin levels increased accordingly. This suggests that though fathers do not experience pregnancy, childbirth or lactation, fathers and mothers may share similar biological changes that encourages infant-parent attachment. In this case, it would be interesting to test whether fathers displayed the same sensitivity to infant-cues and demonstrated patterns of infant bias as observed in mothers. Overall, these are just some of the questions we could ask and further research is required to understand the modulation of self perception during parenthood.

This study the transition into motherhood as a modulating factor for self bias. Most importantly, this is the first time we have observed a stronger bias over the self, whereby an infant bias have shown greater advantage over the self-bias in healthy adults. This marks a significant step toward understanding the changes in the self bias effect in the mother-infant relationship.

Chapter 5

The intrinsic value of self-related information

Abstract

People are typically biased towards self-related information compared with information relevant to others in a wide range of tasks (See Chapter 2 and 3). One main but controversial argument is that self-biased responses reflect the intrinsic value of self-related information (e.g. Northoff & Hayes, 2011). This suggests that self-related information is assessed and measured on a scale similar to monetary reward in the brain (Saxe & Haushofer, 2008). Hence, this chapter investigated the extent of the overlap between monetary reward and self related processing using the perceptual matching paradigm (Sui, He, & Humphreys, 2012). Participants were asked to associate five geometric shapes with five personal labels (e.g. triangle is you) or monetary values (square is £9) and make judgements on whether the shape-label/shape-value parings presented were the correct association in two separate tasks. Results showed no differences in RTs between the high reward and low reward associations in the reward task. Instead, there was an inverted U-shape distribution of the reaction times across the five reward associations. In contrast, the self and mother associations showed robust advantage in RTs over the friend, acquaintance and stranger associations in the social task. Though d-prime was similar between each of the reward values, d-prime for the self association was significantly higher than friend, acquaintance and stranger associations. These results demonstrated a distinct pattern in self and reward processing, which furthers our understanding of the underlying mechanisms of the self bias effect.

Keywords: intrinsic value, self bias, reward

5.1. Introduction

The previous three chapters attempted to demonstrate whether and how self processing is modulated by social factors under different circumstances. Specifically, Chapters 2 and 3 examined the effects of cross culture and social contexts on self processing. Both chapters focused on self processing under different cultural frameworks. The former looked at the differences of self processing as a result of cultural experiences in Hong Kong and UK participants, while the latter examined how priming of the non-prominent framework could modulate self processing. In both cases, a robust self bias effect was found (i.e. greater speed and accuracy in response to self stimuli), though modulation of the self bias was observed when culture was taken into account (*see Chapters 2 and 3*). Chapter 4 on the other hand, discussed the transition of a woman into motherhood and its impact on self processing. In contrast to Chapters 2 and 3, Chapter 4 illustrated the modulation of a reduced self bias effect as a result of motherhood. Women who recently gave birth demonstrated faster and more accurate performance in response to infant stimuli compared to self stimuli. This result was particularly important because it was the first time an obvious loss of the self-bias effect was observed in healthy adults. In light of these findings, it is clear that self processing is a complex and dynamic system of which we understand very little.

In order to further understand the self bias effect, it may be helpful to examine the mechanisms underlying self and reward processes. Specifically, similarities in attentional capture have been observed in both self and reward processes. Both self-related stimuli and high monetary reward have been found to attract more attention both as targets and distractors. As a result, many have speculated that self-related stimuli carry higher intrinsic value than other stimuli, much like higher monetary value is

perceived as more rewarding. The following sections introduced prior research on the relationship between self-related stimuli and monetary reward.

5.1.1. Similarities between self and reward processes

5.1.1.1. Self-related information attracts attention

Self-related information has been found to elicit self bias by attracting more attention and is processed with greater priority. For instance, the "cocktail party" effect reported that individuals were able to detect self-name presented in the unattended ear (Moray, 1959), even when they were unaware of the semantic information presented in that same ear (Cherry, 1953). Using a peripheral cueing task, Alexopoulos and colleagues (Alexopoulos, Muller, Ric, & Marendaz, 2012) presented self-names in specific locations as valid or invalid cues for the location of the target. In valid trials, participants were responded with greater performance (i.e. faster and more accurate responses) when cued with self-name, but not with other-name. Response speed advantage for self-name cued trials was also observed when cues were displayed subliminally. This supported the automaticity of attention to self-related information (Bargh, 1982).

Frings and Wentura (2014) adopted the perceptual matching paradigm and tested actions with the paradigm. Participants associated four personal labels (self, mother, stranger, neutral) with four movements (i.e. up, down, left, right), and made cursor movements according to the cue (an arrow pointing at either up, down, left, or right). Following the movement, a label appeared on screen and the participant had to make a judgment on whether the label and the previous movement matched or not. Significantly faster responses and higher accuracy were observed in the physical actions regarding the self, indicating the effect of self bias on movement.

As distractors, on the other hand, self-related stimuli impair performance as they are harder to ignore than other stimuli. For example, Frings (2006) presented self-name and other-name as distractors, then measured the speed of reaction to these names. It was found that participants can easily ignore names of other participants and demonstrated slower responses to these previously ignored names. In contrast, responses to self-name were not slowed even when self-name was previously ignored.

5.1.1.2. High monetary reward attracts attention

Similar to the self-related stimuli, high monetary reward can also elicit attentional bias. In an ocular competition study, participants showed no bias towards any of the coloured stimuli when no associative learning took place. However, after learning to associate high, low or no reward values with different coloured stimuli, a bias towards the higher reward stimuli was observed in eye movement. Even when reward was no longer delivered, eye movements were biased to land closer towards stimuli previously associated with the higher reward value (Bucker, Silvis, Donk, & Theeuwes, 2015). These findings demonstrated that reward associated learning can manipulate the perceived salience of an otherwise neutral stimuli (Theeuwes, & Belopolsky, 2012).

Anderson, Laurent, and Yantis (2011a) examined reward in a visual search task. Participants searched for the target on a screen with multiple distractors. It was found that distractors that were previously associated with high reward value resulted in delayed search for the target (Anderson, Laurent, & Yantis, 2011a). Further testing also revealed that distractors associated with higher reward were more distracting than distractors associated with lower reward (Anderson, Laurent, & Yantis, 2011b). The

authors concluded that involuntary attentional capture can be driven by associative learning with high reward value.

Based on the research discussed above, it can be concluded that the ability to draw more attentional resources from other stimuli either as the target or as the distractor is a characteristic shared by both self-related stimuli and high reward stimuli. This commonality between the two has led to the proposal that self-related information can be perceived as having higher intrinsic value (Tamir & Mitchell, 2012). In order to investigate whether self-related information and high monetary reward share similar processes, the two need to be measured and compared using a common scale or index (Saxe & Haushofer, 2008). Though current findings on self and reward processes are still ambiguous, many researchers have attempted to explain the relationship between the two.

5.1.2. The intrinsic value of self-related information

Northoff and Hayes (2011) proposed three models to interpret self and reward processes. First, the integration model, which describes the self as almost completely overlaps with reward. In this model, self-related stimuli are perceived as simply high in reward value compared to other stimuli which are assigned with low reward values (e.g. de Greck et al., 2007; Phan et al., 2004). Second, the segregation model suggests almost no-overlap between self and reward, and that self and reward processing are regarded as independent processes (e.g. Enzi, de Greck, Prosch, Tempelmann, & Northoff, 2009). Third, the parallel processing model proposes that parts of the self processes are parallel along the reward continuum (e.g. Yankouskaya, Humphreys, Stolte, Stokes, Moradi, &

Jie, 2017). Although empirical evidence supported each of these three models, none of these models can fully interpret all the findings.

In order to compare the processing of reward values with self-related stimuli, previous studies have used a range of reward and self-related stimuli that corresponded to low, medium and high reward with similar ratios. Each reward value was also matched with comparable self-related stimuli. For example, Izuma, Saito, and Sadato (2008) used ¥0, ¥30, ¥60 Japanese Yen for monetary rewards, while positive trait (e.g. trustworthy), neutral trait (e.g. modest) and no trait adjectives were used as comparable social rewards for the self (i.e. praise from others). In this experiment, Izuma and colleagues argued that reward not only refers to monetary and material goods, but also takes the form of social rewards such as social acceptance and praise from others. Low, medium and high social rewards were compared with ¥0, ¥30, ¥60 monetary rewards and were found to share significant overlap, especially in the left striatum of the brain. The authors concluded that a common system was shared between monetary reward and social reward (i.e. good reputation).

Using the perceptual matching paradigm, Sui and Humphreys (2015) tested the interaction between self and reward behaviourally. Participants associated friend association with high reward value (£8) and stranger association with low reward value (£2) in one session, and friend association with low reward (£2) and stranger association with high reward (£8) in another session. No reward was associated with the self shape-label pair in either session. Despite this, the self exhibited a robust advantage in performance similar to that of the high reward association and both were performed better in comparison to the low reward association. Moreover, high reward association was consistently better than low reward irrespective of the person (i.e. friend or stranger) associated with it. When paired with high reward, high reward friend and high

reward stranger also resulted in better performance than the low reward stranger and low reward friend pairs respectively.

Yankouskaya and colleagues (Yankouskaya et al., 2017) scanned participants who performed the perceptual matching task for self and reward. Each geometric shape was associated with a personal label (self-name, friend-name) and a reward value (£16, £1) and participants were asked to make judgments on whether the shape and label matched or mismatched. Using multi-voxel pattern analysis, it was revealed that the anterior part of the ventral medial prefrontal cortex was engaged in both self and reward processing while the posterior ventromedial prefrontal cortex was only associated with self processing. This shift of activity from reward bias to self bias along the anterior-posterior axis in the ventromedial prefrontal cortex supported the parallel processing model proposed by Northoff and Hayes (2011).

Thus, these findings seemed to indicate a complex relationship between self and reward processes that cannot be fully explained by just one simple model.

5.1.3. Objectives and hypotheses of the current study

In line with previous research, the current study aims to investigate the relationship between self and reward, and the extent of the shared mechanisms between the two processes. Using the perceptual matching paradigm, each participant completed a reward association task and a social association task. In each task, five associations were used. In the reward task, each shape was associated a monetary value at the rate of 1x, 3x, 5x, 7x, 9x. In the social task, each shape was associated with a person (i.e. self, mother, friend, acquaintance, stranger). This study incorporated more associations to examine the gradual changes from one end to another in the reward and social spectrum (i.e. low reward to high reward, self to stranger). This selection of stimuli will provide a

more comprehensive examination of the reward process in comparison to the process of self-relevance.

A main advantage of this within-subject design is that the same paradigm will be used in both reward and social tasks, which allows for the comparison between the responses from personal-labels and reward values without introducing confounding variables. The geometric shapes are similarly familiar to all participants and its association with personal-labels and reward values make the responses more comparable on the same scale.

Taking previous work into consideration, the behavioural hypothesis for this study was: if self-related information is perceived as having higher intrinsic value, similar patterns in the behavioural responses were expected between the self and reward tasks. Specifically, the highest reward value 9x and the self associations would demonstrate a strong advantage in RTs and d-prime compared to the other associations. This response advantage (i.e. faster RTs and higher d-prime) would also decrease as the reward values decreased and the personal labels become more distant from the self. Alternatively, if self-related information is not perceived as having higher intrinsic value, responses to the self and reward tasks would demonstrate different patterns of behavioural results.

Thus, this study compared self and reward processes by testing with the same perceptual matching paradigm. The stimuli for the social task were carefully chosen to try to match the gradients in monetary values in the reward task.

5.2. Methods

5.2.1. Participants

Twenty-one[5] healthy volunteers (4 male, mean age ± standard deviation = 24.33 ± 4.29) took part in this study. All participants were Caucasian, 18 to 35 years of age, right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment. The procedure used in this experiment was approved by the University of Oxford Central University Research Ethics Committee.

5.2.2. Stimuli and materials

Participants completed two computer tasks which used the same paradigm and were presented in the same format. During the computer task, a fixation cross was presented at the centre of the screen at 0.8 x 0.8 degrees of visual angle. One of ten geometric shapes (circle, vertical ellipse, horizontal rectangle, tilted cross, inverted triangle, hexagon, diamond, horizontal ellipse, vertical rectangle and vertical cross) was presented above the fixation cross and a label or a reward value was presented below the fixation cross. The size of the shapes varied in length and width, with a minimum of 3.2 degrees of visual angel and maximum of 6.1 degrees of visual angel. The area of the shapes was controlled around 19,000 square pixels for consistency. Five of the shapes were associated with five personal labels and the other five shapes were associated with five monetary values. The social and reward association tasks were completed in two testing sessions over two consecutive days. For the social task, one of five personal-labels (self, mother, friend, acquaintance, stranger) were displayed at 5.4 x 1.6 degrees of visual angle and for the reward task, one of five reward values (1, 3, 5, 7, 9) were displayed at 1.6 x 1 degrees of visual angle. The distance between the shape/word to the

[5] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 20 subjects were required to achieve *power* = .80, α = .05.

fixation cross was 3.5 degrees of visual angle. The association of shapes with labels was counterbalanced within each task across participants. This means that five shapes – hexagon, diamond, horizontal ellipse, vertical rectangle, vertical cross – were used only in the social task, and the same five shapes were counterbalanced across participants. Within the reward task, the shapes – circle, vertical ellipse, horizontal rectangle, tilted cross, inverted triangle – were used and counterbalanced across participants. Stimuli were presented in a grey background on a 17-in. monitor (1920 x 1080 at 60 Hz). The programme was run on a PC using E-prime software (version 2.0).

Questionnaires were administered at the beginning of the first session (i.e. first day of testing). This included Sensitivity to Reward Scale (Torrubia et al., 2001), *see Appendices A.8*, the Behavioural Activation System (Carver & White, 1994), *see Appendices A.9*, and the Personal Distance Questionnaire (Sui & Humphreys, 2015), *see Appendices A.6*.

5.2.3. Procedure

On the first day of testing (session 1), participants filled out the questionnaires online. Additionally, participants were asked to name their mother, a best friend, an acquaintance and a stranger, and rate their closeness to each person. Then, participants performed one of the two computer tasks – the social association task or the reward association task. Both tasks were developed using the perceptual matching paradigm (Sui, He, Humphreys, 2012). The order of the two tasks was counterbalanced across participants.

Each association task included a learning phase and a testing phase. In the learning phase, participants learned to associate a shape with a label. For example, in the social association task, the participant was instructed that the hexagon represents

yourself, the diamond represents your mother, the horizontal ellipse represents your best friend, the vertical rectangle represents your acquaintance, and the cross represents the stranger. In the reward association task, the circle represents £1, vertical ellipse represents £3, horizontal rectangle represents £5, tilted cross represents £7, and the upside-down triangle represents £9. During the computer task, a mixture of the correct associations and incorrect recombination of a shape with a label were presented on the screen, and the participant was asked to make judgments on whether the shape and label pair presented on the screen was the correct association or not. The participant was instructed to make a response as quickly and accurately as possible by pressing one of the two keys on the keyboard with the right hand. A short practice block of 20 trials was performed before the experimental trials.

In the testing phase, a fixation cross was presented at the centre of the screen for 2000ms at the beginning of each trial. Then a shape and label above and below the fixation cross appeared for 100ms, followed by a blank screen for 1100ms as a response time window. Feedback was given for 500ms after each response, in the form of green "Correct" or red "Incorrect". If no response was given within the response time limit, a yellow "Too Slow!" was displayed to prompt faster response. The overall accuracy was reported at the end of each block, see *Figure 17*. The break between two blocks was participant-stepped, and the shape-label associations were displayed during the break as well. The testing phase consisted of five blocks of 120 trials.

On the second day of testing (session 2), the participant completed the other computer task thus that each participant completed one reward association task and one social association task over the span of two days.

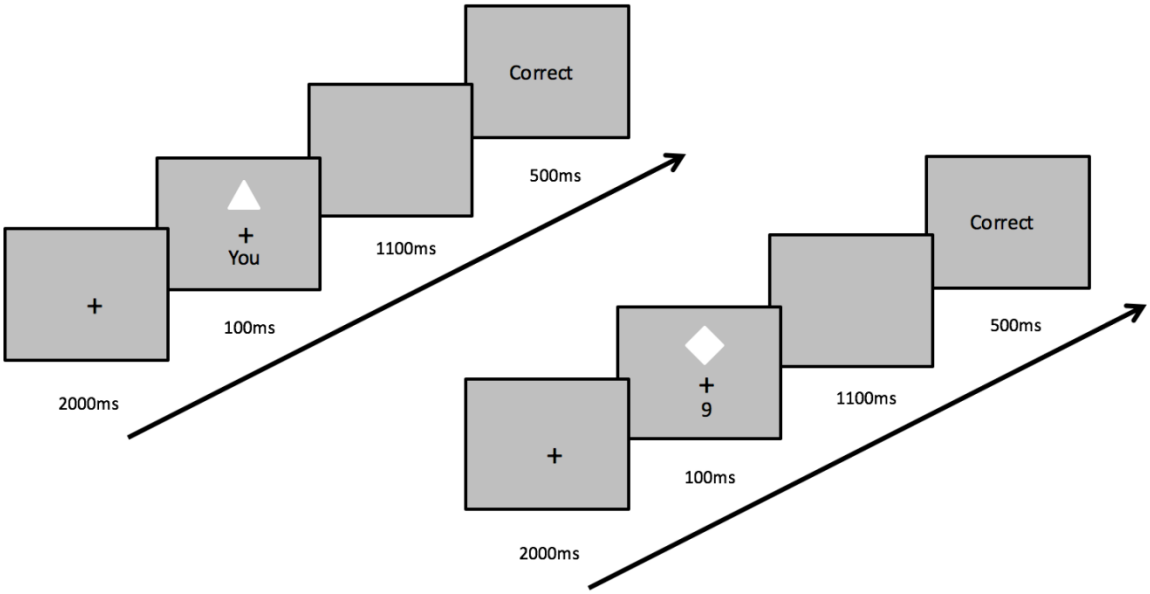


Figure 17. Left: stimulus example and trial procedure for the social task. Right: stimulus example and trial procedure for the reward task.

5.2.4. Experimental design and data analyses

The current study used a 2 (task: reward or social) x 5 (shape-label associations: 9x, 7x, 5x, 3x, 1x or self, mother, friend, acquaintance, stranger) design. Behavioural results from the reward and social tasks were analysed and reported in two sections: RTs in match trials and d-prime. Mean correct RTs were calculated for each participant in each computer task, responses made within 200ms were excluded. The data were cleaned by removing RTs that were more than 3 standard deviations outside the mean for each condition. This eliminated less than 1% of the trials overall. D-prime (*d'*) (Green & Swets, 1966) was calculated for each participant to determine one's sensitivity to correct and incorrect shape-based associations across both matching and non-matching shape-label associations. Questionnaire analyses are reported in Chapter 7.

Bonferroni correction was applied for multiple comparisons (Holm, 1979) in paired-samples t-tests. The following results were reported in relation to the bias towards self and high reward so that comparisons can be made between the two processes in an attempt to determine whether self-related stimuli were perceived as having higher intrinsic value.

5.3. Results

5.3.1. RTs in match trials

RTs from the match trials in the reward and social tasks were analysed with a repeated measures ANOVA using two within-subjects factors – task (reward or social) and shape-label association (1x, 3x, 5x, 7x, 9x or self, mother, friend, acquaintance, stranger), *see Table 15 for mean RTs from both tasks*. This revealed a significant main effect of task, $F(1, 20) = 5.55$, $p < .05$, $\eta^2 = .22$. The mean RT for the reward task was significantly faster than mean RT for the social task ($p < .05$). A main effect of shape-label association was also found, $F(4, 80) = 9.85$, $p < .001$, $\eta^2 = .33$. Across tasks, mean RTs for the 9x and self associations were significant faster than the 7x and mother associations ($p < .05$), 5x and friend associations ($p < .05$), 3x and acquaintance associations ($p < .001$), 1x and stranger associations ($p < .001$). Most importantly, there was a significant interaction between task and shape-label association, $F(4, 80) = 15.78$, $p < .001$, $\eta^2 = .44$.

Table 15. Mean RTs (ms) and SDs (in brackets) for match trials as a function of task and association.

Reward associations	Match RTs	Social associations	Match RTs
9x	645 (57)	Self	639 (53)
7x	676 (50)	Mother	654 (52)
5x	670 (61)	Friend	687 (62)
3x	678 (62)	Acquaintance	694 (61)
1x	626 (46)	Stranger	702 (45)
Mean	659 (58)	Mean	675 (59)

Each task was analysed separately to decompose the interaction between task and shape-label association. Within the reward task, a repeated measures ANOVA with a within-subjects factor – shape-label association – was performed. The analysis revealed a significant main effect of shape-label association, $F(4, 80) = 9.84$, $p < .001$, $\eta^2 = .33$, *see Table 15 and Figure 18.* Paired samples t-tests were performed to examine the differences in RTs between any two reward values. The data showed that the RTs for the high reward 9x was significantly faster than those to the 7x, $t(20) = 3.53$, $p = .002$, $dz = .56$, and 5x, $t(20) = 2.68$, $p = .014$, $dz = .42$, as well as 3x, $t(20) = 3.01$, $p = .007$, $dz = .54$, *see Figure 18*. However, responses to the high reward 9x did not differ from the low reward 1x, $t(20) = -1.77$, $p = .09$, $dz = .37$.

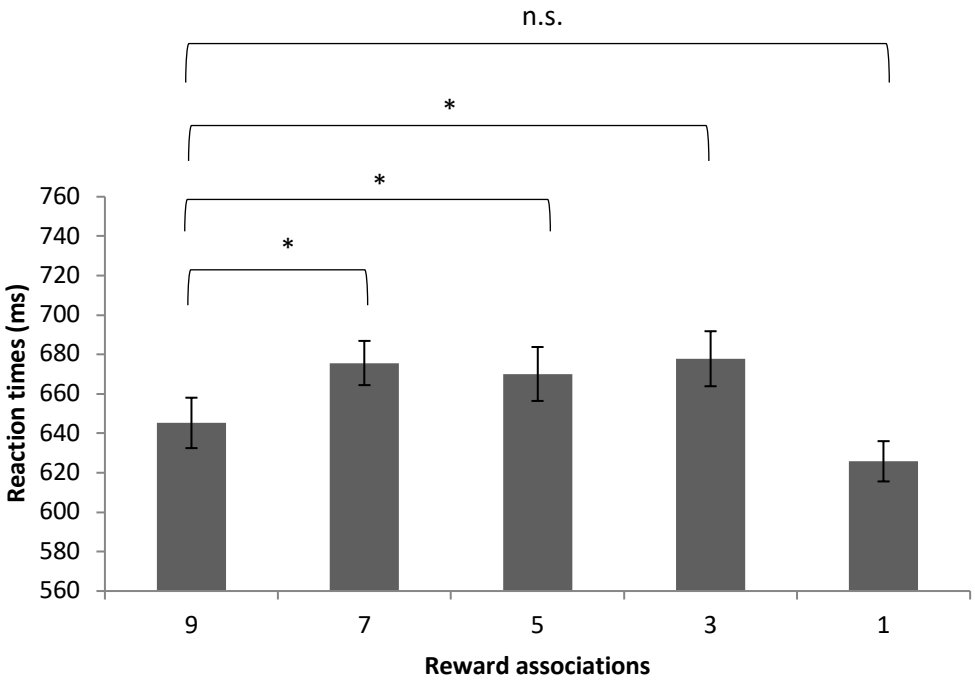


Figure 18. RTs on match trials in the reward task as a function of shape association. Error bars represent one standard error. Significant differences between associations are marked with ''*

The analysis of RTs in the social task showed a significant main effect of shape-label association, $F(4, 80) = 15.19$, $p < .001$, $\eta^2 = .43$, *see Table 15 and Figure 19.* No differences were found between the self and the mother associations, $t(20) = -1.53$, $p = .14$, $dz = .29$. Though, responses to the self association were significantly faster than those to the friend, $t(20) = -4.04$, $p = .001$, $dz = .82$, acquaintance, $t(20) = -5.90$, $p < .001$, $dz = .97$, and stranger associations, $t(20) = -5.26$, $p < .001$, $dz = 1.27$.

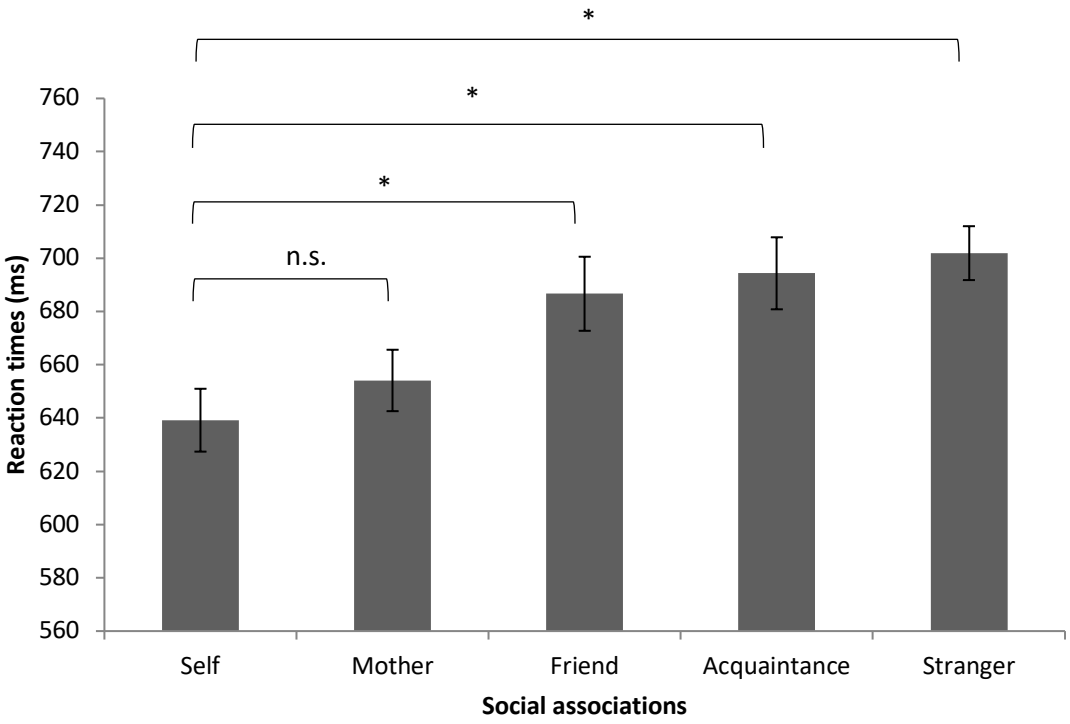


Figure 19. RTs for the match trials in the social task as a function of shape association. Error bars represent one standard error. Significant differences between associations are marked with ''.*

5.3.2. D-prime

A repeated measures ANOVA with two within-subjects factors – task and shape-label association – was performed, *see Table 16 for mean d-prime from both tasks*. The analysis showed a significant main effect of shape-label association, $F(4, 80) = 5.57$, $p = .001$, $\eta^2 = .22$, but not for task $F(1, 20) = .32$, $p = .58$, $\eta^2 = .02$. Pairwise comparison of the shape-label association indicated that across tasks, mean d-prime for the 9x and self associations were significant higher than d-prime for the 5x and friend associations ($p < .05$), but was similar to the d-prime for the 7x and mother associations

(p = .40), 3x and acquaintance associations, (p = .11), and 1x and stranger associations (p = .10). A significant interaction was found between task and shape-label association, $F(4, 80) = 3.26$, $p < .05$, $\eta^2 = .14$.

Table 16. Mean d-prime and SDs (in brackets) for both match trials and mismatch trials as a function of task and association.

Reward associations	D-prime	Social associations	D-prime
9x	3.30 (1.09)	Self	3.44 (.95)
7x	2.79 (.86)	Mother	3.20 (1.09)
5x	2.82 (.97)	Friend	2.46 (.57)
3x	2.88 (1.02)	Acquaintance	2.78 (1.03)
1x	3.14 (.92)	Stranger	2.60 (.81)
Mean	2.99 (.98)	Mean	2.90 (.97)

Next, an analysis was performed for each of the two tasks separately with one within-subjects variable – shape-label association. In the reward task, no significant main effect of shape-label association was found, $F(4, 80) = 1.87$, $p = .13$, $\eta^2 = .09$, *see Table 16 and Figure 20.*

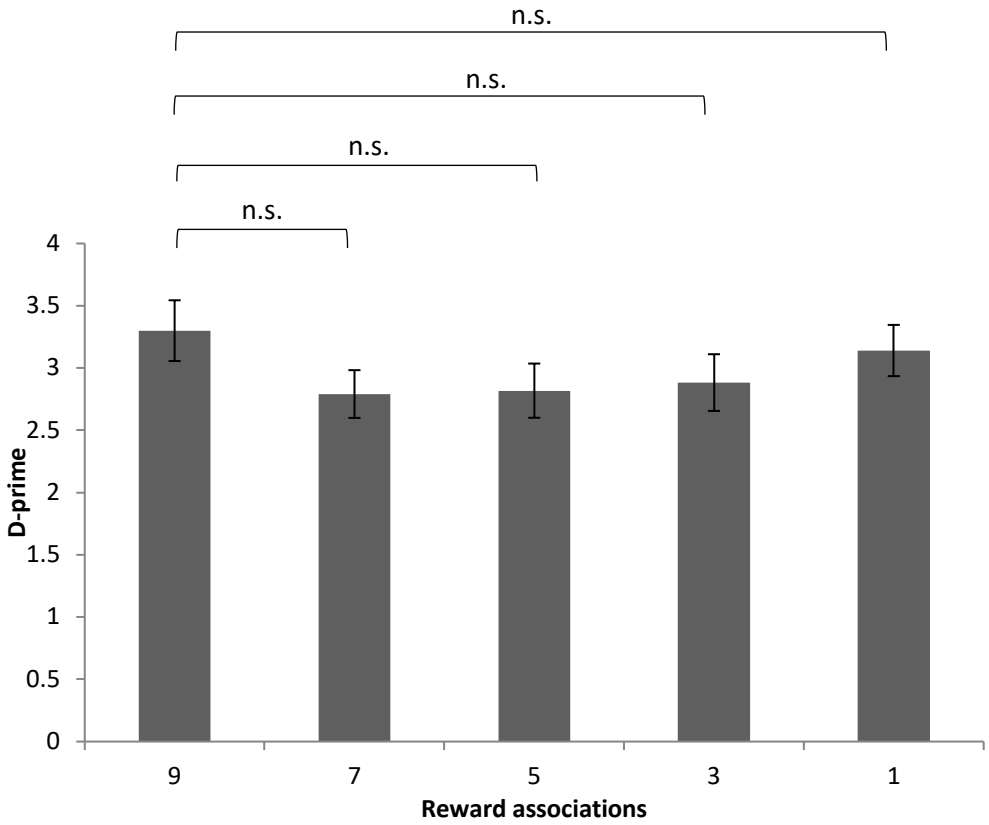


Figure 20. D-prime as a function of association in the reward task. Error bars represent standard errors.

In contrast, the analysis in the social task showed a significant main effect of shape-label association, $F(4, 80) = 7.77$, $p < .001$, $\eta^2 = .28$, *see Table 16 and Figure 21.* Paired samples t-tests revealed that the d-prime for the self association was significantly larger than for friend, $t(20) = 5.00$, $p < .001$, $dz = 1.18$, acquaintance, $t(20) = 3.22$, $p = .004$, $dz = .67$, and stranger, $t(20) = 4.71$, $p < .001$, $dz = .95$. However, the self d-prime was not different from the mother d-prime, $t(20) = .85$, $p = .407$, $dz = .23$, *see Figure 21.*

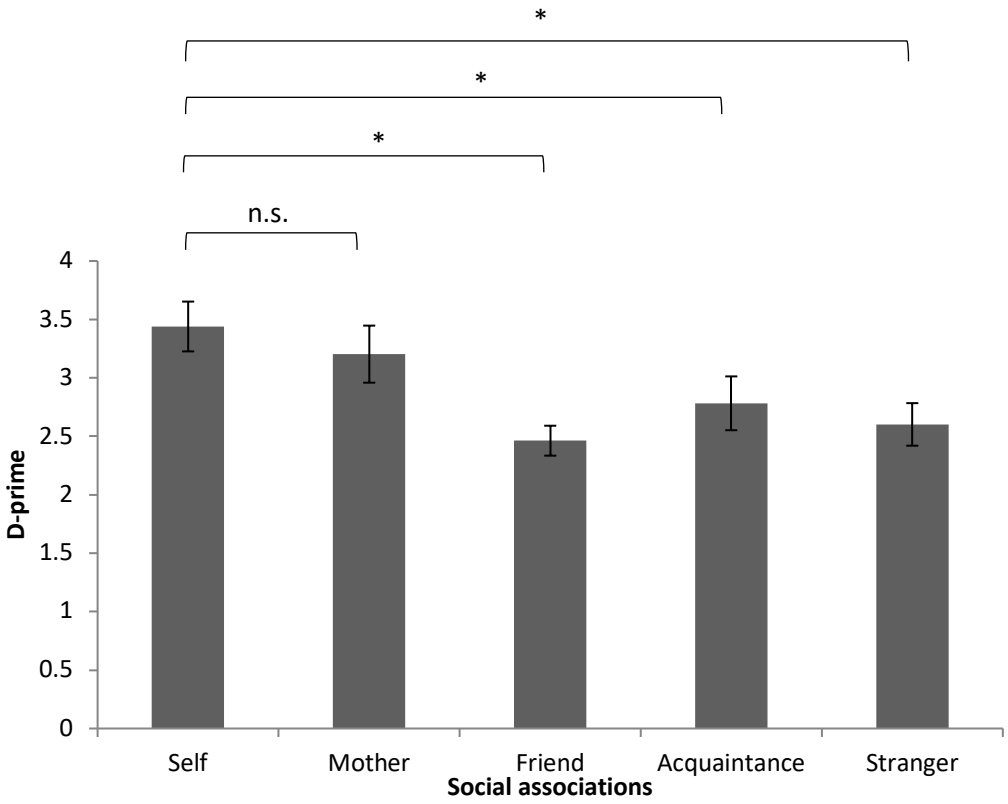


Figure 21. D-prime as a function of association in the social task. Error bars represent standard errors. Significant differences between associations are marked with ''.*

5.3.3. Correlation analyses

Correlations analysis on the relationship between the behavioral responses and the questionnaire measures are reported in Chapter 7.

5.4. Discussion

The goal of this experiment was to examine the relationship between self and reward processing, as well as to understand the mechanisms underlying the self bias effect. It was hypothesised that if there was a higher intrinsic value to self-related

information, the behavioural results would show the same pattern of RT distributions in both social and reward tasks. However, if self-related information does not carry higher intrinsic value, then the distribution of the social and reward tasks would be different.

5.4.1. Findings and implications

Comparisons of the behavioural results from the social and reward tasks seemed to indicate partially distinct self and reward mechanisms. Whilst the RT distribution of the reward task resulted in an inverted U-shape distribution, the social task demonstrated a gradual increase of RTs. Although a robust self bias effect was found, where the self stimuli elicited the fastest responses, both the lowest reward (i.e. 1x) and the highest reward (i.e. 9x) prompted similar performance. This indicated that high reward value is not the only factor that motivates fast responses and that other unknown factors induced fast reaction times to the lowest reward value too. On the other hand, the self bias effect only led to fastest responses to self stimuli. This difference in the social and reward tasks imply that the processing of self-related stimuli cannot be completely attributed to having higher intrinsic value. Rather, other factors are at play that consistently facilitate and produce the best performance in response to self-related information. These other factors may be attributed to differential representations in the brain. For example, Yankouskaya and colleagues found that while both self and reward processes were associated with activity in the anterior ventromedial prefrontal cortex, activity in the posterior ventromedial prefrontal cortex was only related to self processing (Yankouskaya et al., 2017). However, further research is needed to determine what other factors consistently facilitate the self bias effect.

In the reward task, the inverted U-shape distribution of the RTs and a lack of advantage in detecting high reward value 9x in comparison to the other reward values

1x, 3x, 5x and 7x seemed to suggest that high rewards do not necessary predict better performance. A possible explanation for the inverted U-shape distribution is that the five shape and label pairs were too taxing on visual memory. In order to memorise all of the shape-label associations, the lowest and highest reward values may have been used as anchors or reference points to facilitate memory. Thus, the points of reference – 1x and 9x – showed better RT performance than the associations in between. Similarly, d-prime was numerically higher for the high reward 9x compared to all other reward values except 1x. Even though the difference was not significant, the trend of d-prime scores was consistent with the RT pattern. Participants may have been too preoccupied with memorising the correct associations than focusing on the monetary reward values. Thus, the high reward value was unsuccessful at motivating better performance and an inverted U-shape distribution of the results was found.

In the social task, a robust self bias effect was found consistent with previous findings (*see Chapters 2 and 3*). The distribution of the mean RTs demonstrated a steady increase in response time as the personal labels became more distant from the self. Though, response to the self association was only minimally faster than that of the mother association, the difference was not significant. D-prime results showed the same patterns as the RT results. This is particularly interesting in that it is inconsistent with previous findings in British participants. Previously, participants from independent cultures often demonstrated a dissociation between self and mother processing (e.g. Sui, He, & Humphreys, 2012; Zhu, Zhang, Fan, & Han, 2007). However, this difference between self and mother was not observed in this particular task. This may be due to the fact that there are more associations with other non-family members such as friend, acquaintance and stranger in this study. It is possible that the number of other-related stimuli may have, subconsciously, prompted the self to be more aware of the only

family member (i.e. mother) so that more resources can be distributed towards family members to ensure the survival of one's own genes (Hamilton, 1964; Han, Ma, & Wang, 2016; Platek & Kemp, 2009). However, this is outside the scope of the current study and more research is required to explain this phenomenon. Regardless, the distribution of the social task demonstrated a gradual increase from self to stranger.

In line with these findings, the comparison of the results between the social and reward tasks demonstrated different patterns, which suggested that self-related information may not be completely perceived as having higher intrinsic value and that partially differential mechanisms underlie self-related processes and reward processes.

5.4.2. Significance of this study

A significance of this study was the investigation of the relationship between the self and reward processes. The use of the same paradigm allowed the current study to make parallel comparisons between the two processes without introducing other variables whilst using the same metric. Hence, the pattern of the behavioural results could be used as an index to determine whether self-related information was processed in a similar fashion to high reward.

Another significance was in the use of five associations in each of the reward and social task. This allowed for the observation of the gradient of the responses from highest (i.e. 9x) to lowest reward (i.e. 1x) and from most familiar (i.e. self) to least familiar (i.e. stranger). Compared with previous research that compared three reward values to three social stimuli (e.g. Izuma, Saito, Sadato, 2008; Yankouskaya et al., 2017), the results from this study provided a more comprehensive view of the gradual changes in information processing by expanding the spectrum of the target stimuli. Moreover, the use of acquaintance instead of partner (in Yankouskaya, Buhrle, Lugt,

Stolte & Sui, 2018) matched the five reward associations in the gradual increase between the stimuli. Yankouskaya and colleagues (2018) compared reward values – 1, 3, 5, 7, 9 – with personal labels – self, mother, partner, friend, stranger. The key distinction between this study and Yankouskaya's study was the use of acquaintance as one of the personal labels. It can be argued that partner (in Yankouskaya et al., 2018), as a measure, can be inconsistent between subjects depending on the length of the relationship and the degree of intimacy. However, acquaintance is more consistent in that it is defined as someone who is not yet considered a friend but is not a complete stranger. Hence, the self related stimuli reflected the same gradual increase – from closest to furthest from the self (self, mother, friend, acquaintance, stranger) – as the monetary reward stimuli – from lowest to highest value (1x, 3x, 5x, 7x, 9x).

The current study relied on behavioural measures to investigate the relationship between self and reward processes as well as the underlying mechanisms. Current findings indicated that the self bias effect is not the result of higher intrinsic value associated with self-related information and that the underlying mechanisms of self and reward processes do not overlap. This contradicts the integration model proposed by Northoff and Hayes (2011). However, behavioural measures require overt responses and represent the combined effort of many cognitive processes (Fields & Kuperberg, 2012). To further understand the underlying mechanisms of self and reward processes in the brain, the next chapter (Chapter 6) examined the two by measuring the electrophysiological responses to self and reward stimuli using ERP technique.

Chapter 6

An electrophysiological approach to the self bias effect and reward processes

Abstract

To further understand the underlying mechanisms of the self bias effect and its relationship to reward processing, the current study examined the electrophysiological responses to reward and self-related information using the event-related potential (ERP) technique. This allowed the measure of continuous activities in the brain after stimulus onset with higher temporal resolution. Three key ERP components – P300, N1, N2 – were examined to compare reward and self processes. Adapting the perceptual matching paradigm from the previous chapter (Chapter 5), electrophysiological responses were recorded as the participants made judgments about whether the shape and label was the correct association or not. The analysis on N1 demonstrated increased voltage in response to mother but decreased voltage to self, whilst the highest reward (i.e. 9x) elicited the highest amplitudes and the moderate reward (i.e. 5x) elicited the lowest amplitudes. Amplitudes of the P300 were highest for the self and lowest for stranger in the social task, whilst the amplitudes were highest for both the lowest reward (i.e. 1x) and the highest reward (i.e. 9x) in the reward task. N2 failed to produce any significant differences between the social and reward tasks. The use of the same paradigm in this study allowed parallel comparisons of the self and reward processes, which contributes to current understanding of how the underlying cognitive processes differ between self and reward.

Keywords: intrinsic reward, self bias, reward processing, ERP, N1, N2, P300

6.1. Introduction

In the previous chapter, self-related processing was compared with reward processing using the same perceptual matching paradigm. Each reward value and personal label was associated with a geometric shape, which allowed us to make comparisons between the two dimensions on the same scale. Results from the last chapter demonstrated different patterns of behavioural responses to the reward values and personal labels. These findings suggested differential mechanisms of reward processing and self-related processing in the brain. However, behavioural responses are the combined efforts of multiple stages of information processing in the brain (Fields & Kuperberg, 2012), which makes it difficult to examine the dynamic processes that occur between stimulus onset and response. Thus, the goal of this chapter was to investigate the underlying cognitive processes related to the self and reward, as well as the relationship between the two, through the study of event related potentials (ERP).

The ERP technique measures the electrical potentials that travel through the brain. The advantage of ERP studies is the ability to provide high temporal resolution on the continuous brain activities after stimulus onset, even in the absence of an overt response (Luck, 2014). Moreover, the distribution of the electrical potentials over the scalp can help locate specific cognitive processes (Luck, Woodman & Vogel, 2000). Segments of the electrical responses, known as epochs, after stimulus onset are extracted to form a grand average waveform for each stimulus type. The averaged ERP waveforms consist of waves of positive and negative peaks commonly known as components. These components are typically named with a letter P or N to indicate its polarity, followed by a number that indicates the time of the peak after stimuli onset. For example, a positive deflection that peaks around 100 ms after stimuli onset is

named P100 or P1, and a negative peak at 100 ms is named N100 or N1. Identifiable components have been found to reflect various cognitive processes (Luck, 2014).

The following section introduces three components – N1, N2, P300 – that have previously been studied in association with self-related information as well as reward. In particular, the N1 and P300 components have been chosen on the basis that both are sensitive to attention as well as the perceived significance of the stimuli. In addition, N2 has been chosen due to its sensitivity to perceptual salience. Hence, the ERP results were analysed according to these presumptions, and the introduction and results sections were written in this order rather than the temporal order typically reported in EEG studies.

6.1.1. Components associated with attention and significance of the stimuli – N1 and P300

The previous chapter (Chapter 5) investigated the relationship between self and reward processes on the basis that both self-related stimuli and high monetary reward captures attention involuntarily (*see 5.1.1*.). Therefore, the N1 and P300 components, which are known to reflect attention as well as the perceived significance of the stimuli are examined to further understand self and reward processes.

6.1.1.1. N1

The N1 is an early component involved in visual and selective attention (Luck, Woodman, & Vogel, 2000). N1 consists of many different subcomponents such as the anterior N1 and posterior N1, which are both associated with visuo-spatial attention (Hillyard, Vogel & Luck, 1998; Mangun, 1995). In addition, the visual N1 which peaks around 160ms in the occipital-temporal region has been found to demonstrate enhanced

voltage during tasks that requires the discrimination and identification of the stimuli (Hopf, Vogel, Woodman, Heinze, & Luck, 2002; Vogel & Luck, 2000). The ability to discriminate and identify stimuli, as opposed to simple detection responses, is crucial to the performance of the perceptual matching paradigm in this study as the participants must discriminate between the different shapes.

Moreover, the amplitude of the N1 is also sensitive to stimuli that carry social or motivational significance. For example, studies that presented emotional vs. neutral pictures to the participants found larger N1 amplitudes after emotional stimuli than after neutral stimuli (Foti, Hajcak, & Dien, 2009; Keil et al., 2001). Plihal and colleagues showed food-related words to participants who were either hungry or satiated. Larger N1 amplitude was observed in hungry participants than satiated participants (Plihal, aenschel, Hachl, Born & Pietrowsky, 2001). Liu, He, Rotshtein, and Sui (2016) cued target locations with self-face, friend-face and stranger-face. Increased N1 was observed in response to self-face cues compared to face cues of friend and stranger.

Similarly, reward-related stimuli also elicit a larger N1. In one study, participants performed the Stroop task with cues that indicated prospective reward or no reward conditions. Cues that indicated prospective reward elicited larger N1 despite incorrect responses resulting in loss of monetary reward (van den Berg, Krebs, Lorist, & Woldorff, 2014). The authors concluded that the increase in N1 amplitudes to prospective reward cues reflected enhanced attentional-control processing due to the significance of the cues (Hickey, Chelazzi, & Theeuwes, 2010; van den Berg, et al., 2014). Enhancement of N1 voltage in response to reward has also been found when reward is delivered immediately rather than later (Blackburn, Mason, Hoeksma, Zandstra, & El-Deredy, 2012). This is due to the fact that delayed rewards are perceived

to decrease in value, or motivational significance, compared to immediate rewards (Rick & Loewenstein, 2008).

Thus, the N1 component plays an important role in studying the processing of self and reward stimuli in terms of attention and motivational significance.

6.1.1.2. P300

The P300 is maximal at centro-pariental locations. This component was first reported by Desmedt and colleagues (Desmedt, Debecker & Manil, 1965; Sutton, Braren, Zubin, & John, 1965) and has been widely studied ever since. In particular, the P300 has been found to reflect cognitive processes (Miyakoshi, Nomura & Ohira, 2007) such as attention (e.g. Polich, 2007; Radlo, Janelle, Barba, & Frehlich, 2001; Rohrbaugh, Donchin, & Eriksen, 1974). The P300 has been reported to correspond with the amount of attentional resources allocated to processing the stimuli (Johnson, 1988) whilst remain unaffected by the behavioural response to the stimuli (Crites, Cacioppo, Gardner & Berntson, 1995). In other words, the amplitude of the P300 is larger when the task requires more effort (Isreal, Chesney, Wickens, & Donchin, 1980). Amplitudes of the P300 have also been associated with the relevance of the stimuli. Johnston, Miller and Burleson (1986) proposed the emotional value hypothesis of the P300, suggesting that stimuli with high significance, or emotional value, to the participant would elicit attentional resources even when irrelevant to the primary task.

Tacikowski and Nowicka (2010) examined the relationship between the P300 and self-relevant stimuli using self-face and self-name. Participants viewed names and faces on screen and were asked to categorise the stimuli as familiar or non-familiar. The name stimuli included self-name, name of famous people and unknown names, and the face stimuli consisted of self-face, faces of famous people, and unknown faces.

Findings demonstrated significantly higher amplitudes in the P300 for the self-name and self-faces when compared to famous and unknown names and faces. Additionally, the P300 to self-name and self-face were both similar in amplitude and also correlated with each other, which suggested that different kinds of self-related stimuli captured similar amounts of attentional resources. Moreover, these findings confirmed that the P300 responses varied as a result of the motivational significance of the stimuli, with self-face and self-name being the most significant. The authors concluded that the P300 can be interpreted as an index for both allocation of attentional resources and emotional significance of the stimuli.

Gray and colleagues (2004) conducted an experiment where participants viewed autobiographically self-related words (e.g. name of participant's hometown, high school, or participant's middle name) on screen with target words displayed in red and other non-target words (e.g. names of hometowns, high schools, or middle names not related to the participant). Participants were instructed to respond only to the red target words. Target words were randomly chosen and not always self-related. It was found that the P300 elicited by self-related stimuli were similar in amplitude to the red target words, even when the self-related stimuli were irrelevant to the task. This demonstrated that not only self-names attract more attention, but autobiographically self-related stimuli also carry high emotional significance to the participant, which captures attentional resources irrespective of task relevance.

The P300 is also sensitive to high rewards. In a gambling game, Yeung and Sanfey (2004) studied the ERP responses to high and low reward. Participants selected one of two cards on the computer, which either led to gain or loss of monetary reward. Depending on the colour of the cards, the gains or losses were either large or small in amount. Results showed that the amplitude of the P300 increased with the magnitude of

the reward, with an enhanced response to a larger rather than a smaller reward irrespective of gain or loss. These findings were replicated in a similar study by Sato and colleagues (Sato et al., 2005), where correct or incorrect prediction of the value of the proceeding card (in comparison to the cue card) resulted in monetary gain or loss respectively. Amplitude of the P300 corresponded with the magnitude of the value but not the gain or loss of monetary reward. This phenomenon (i.e. modulation of the P300 due to the value of the reward) was explained that the P300 increased as a result of the motivational significance of greater gains and losses rather than the magnitude of the reward.

Consequently, the P300 is a key component to understanding how self-related information and high reward are processed with regards to the allocation of attentional resources and perceived significance of the stimuli.

6.1.2. Other relevant component - N2

Other than N1 and P300, which have been demonstrated to be particularly relevant to the current study, the N2 component was also examined due to its relationship with perceptual salience.

The anterior N2 located in the frontal-central region has been found to be sensitive to the perceptual salience of the stimuli (Folstein & van Petten, 2008). Research findings have documented the involvement of N2 with both self-related stimuli and reward processing. Fan and colleagues (Fan et al., 2013) examined the reaction to names using ERP. Participants viewed a highly self-relevant name (i.e. self-name), a moderately self-relevant name (i.e. father's name), a minimally self-relevant name (i.e. leader of the country's name), a non-self-relevant name (i.e. leader of another country's name) along with a control word and the target stimulus (i.e. a non-lexical

word). The task was to push a button only when the target stimulus appeared. Results of the study showed that the self-name elicited higher amplitudes of N2 than any of the other names.

Similar results were found in other studies. A study using handwritings asked participants to view either own-handwriting that belonged to the participant or handwriting of others and made judgements on whom the handwriting belonged to. The results showed increased amplitudes and earlier latency for own-handwriting than for other-handwriting (Chen et al., 2008). Fan and colleagues (Fan et al., 2011) also found larger amplitudes in response to self-name and self-national flag compared with other names and flags. The authors concluded that self-related stimuli automatically capture attention due to the saliency of the self-relevant information.

Amplitudes of the N2 component also vary with reward. In an experiment using a flanker task, participants were asked to press one of two buttons in response to the stimuli. In the reward condition, a monetary reward was given for the correct response and no punishment was given for the incorrect response, but in the punishment condition, incorrect responses led to monetary loss. Participants showed slower responses and larger anterior N2 in the punishment condition (Potts, 2011). It was concluded that the attempt to avoid monetary punishment seemed to have an effect on processing.

This suggested that the N2 also reflect some degree of attentional mechanism in response to salient stimuli (e.g. Chen et al., 2011; Folstein & van Petten, 2008).

6.1.3. Objectives and hypotheses of the current study

Based on the findings from the previous chapter (*see Chapter 5*), the goal of the current experiment was to further explore the underlying cognitive processes associated with self and reward through the use of ERP technique.

Similar to the last Chapter (*see 5.1.2 in Chapter 5*), the current study used the same perceptual matching paradigm to test both social and reward associations. This consisted of five personal labels for the social task – from closest to furthest from the self (i.e. self, mother, friend, acquaintance, stranger) – and five monetary reward values for the reward task – from lowest to highest value (1x, 3x, 5x, 7x, 9x). Testing with the same paradigm would allow comparisons to be made between the results from social and reward tasks on the same metric scale. However, instead of presenting both shape and label stimuli on the same screen (*see 5.2.3 in Chapter 5*), each shape and label stimulus was presented on screen in sequential order. This ensured that the electrophysiological responses recorded with the ERP technique were associated with only the shape stimulus rather than in response to the label text. This would also maximise the number of valid trials in the ERP data since match or mismatch responses would not be taken into account during this stage of the ERP recording.

In line with previous research, it was hypothesised that stimuli carrying higher significance, such as self-related stimuli and high reward stimuli, will receive preferential access to attentional resources, and thus induce increased amplitudes in the N1, P300 and N2 components respectively.

6.2. Methods

6.2.1. Participants

Thirty-two[6] healthy volunteers (12 male, mean age ± standard deviation = 22.11 ± 2.62) took part in this study. All participants were Chinese, 18 to 35 years of age, right-handed and had normal or corrected-to-normal vision. Informed consent was obtained from all participants prior to the experiment. The procedure used in this experiment was ethically approved by the Institutional Review Board at Tsinghua University. Due to bad signal, data collection from four participants were incomplete and thus were excluded from the analyses.

6.2.2. Stimuli and materials

The stimuli used in this study were the same as those used in Chapter 5, except that the shape and label was presented consecutively rather than simultaneously on the screen. Additionally, instructions and labels were presented in Chinese. Each trial of the computer task started with a fixation cross presented at the centre of the screen at 0.8 x 0.8 degrees of visual angle for 500 ms. Then, one of ten geometric shapes (circle, vertical ellipse, horizontal rectangle, tilted cross, inversed triangle, hexagon, diamond, horizontal ellipse, vertical rectangle or vertical cross) was presented in the centre of the screen for 100 ms. The size of the shapes varied in length and width, with a minimum of 3.2 degrees of visual angel and maximum of 6.1 degrees of visual angel. The area of the shapes was controlled around 19,000 square pixels for consistency between stimuli. Another 800 ms of fixation cross at the centre was presented followed by the label (self, mother, friend, acquaintance, stranger in mandarin Chinese for the social task and 1, 3, 5, 7, 9 for the reward task) displayed in the centre of the screen for 100 ms at 2.0 x 1.3 and 1.0 x 1.3 degrees of visual angel for the social and reward labels respectively.

[6] Based on the effect size from previous research (e.g. Sui, He & Humphreys, 2012), a minimum of 20 subjects were required to achieve *power* = .80, α = .05.

Stimuli were presented in a grey background on a 21-in. monitor (1024 x 768 at 100 Hz). The programme was run on a PC using E-prime software (version 2.0).

The questionnaires administered were the same as in Chapter 5 –Sensitivity to Reward (Torrubia et al., 2001), *see Appendices A.8*, Behavioural Activation System (Carver & White, 1994), *see Appendices A.9*, and the Personal Distance Questionnaire (Sui & Humphreys, 2015), *see Appendices A.6*.

6.2.3. Procedure

This study was completed in the same procedure as the behavioural reward study from the last Chapter (*see 5.2.3 in Chapter 5*), except that the entire study was administered in Mandarin Chinese and the shape and label stimuli were presented in sequential order rather than together on the same screen.

At the beginning of each trial, the fixation cross was presented at the centre of the screen for 500ms, which was followed by a shape presented at the centre of the screen for 100ms. Then, another fixation cross was displayed at the centre for 800 ms followed by the label presented at the centre of the screen for 100 ms. A blank screen of 1100ms was presented after the label as the response time window. Feedback was given for 500ms after each response, in the form of green "Correct" or red "Incorrect". If no response was given within the response time limit, a yellow "Too Slow!" was displayed to prompt faster responses. The inter-trial interval ranges from 1000 to 1400 ms. Overall accuracy of each block was reported at the end, see *Figure 22*. The break between two blocks was participant-controlled, and the correct shape-label associations were displayed during the break as well. Ten blocks of 120 trials were administered during the testing phase to ensure that there were 120 trials per condition for the ERP data analysis.

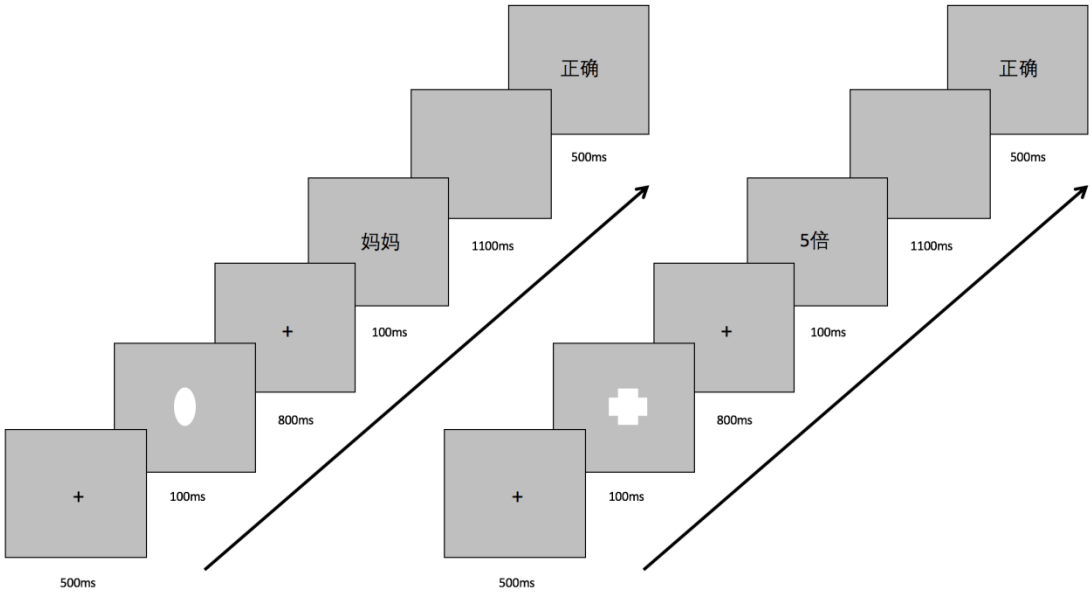


Figure 22. An example of the trial procedure for the social task (left) and reward task (right).

6.2.4. ERP data recording and analyses

Electroencephalography (EEG) was recorded from 64 sites using the international 10-20 system. Electrooculogram (EOG) was recorded using electrodes above the left and right eye. Cortical electrode impedances did not exceed 5KΩ. Cortical physiology signals were amplified and filtered using the actiCHamp from Brain Products (BrainProducts, Gilching, Germany). EEG at each electrode was measured with the left mastoid (TP9) as reference and was re-referenced off-line to the average for both mastoids (TP9 + TP10/2) (Miller, Lutzenberger, & Elbert, 1991). High- and low-pass filters were set at 0.05 and 30 Hz, respectively. Digital sampling occurred at 500Hz. ERPs were averaged offline using Brain Vision Analyzer (BrainProducts, Gilching, Germany), which extracted epochs beginning 200 ms before

stimulus onset and continuing to 800 ms after stimulus onset. Grand-averaged waveforms were calculated for each shape stimulus condition by averaging the epochs from each electrode sites for each participant. The P300 component was averaged from 300 – 400 ms time window after stimulus onset at parietal-occipital electrode sites – Cz, CPz, Pz, POz. The N1 component was extracted from occipital electrodes – Oz, O1, O2 – at 100 – 150 ms after stimulus onset. The anterior N2 component was calculated using frontal-central electrodes – Fz, FCz, Cz – from 210 – 280 ms after stimulus onset. The time window for each component was selected based on the latency of the averaged waveform for each component as well as the strength of the activity demonstrated by the topographic maps for each component.

6.2.5. Experimental design and data analyses

Findings are reported in two sections below: behavioural results and electrophysiological results. The behavioural results for the reward and social tasks were analysed separately and are reported under two subheadings – RTs in Match Trials and d-prime. Mean correct RTs were calculated for each participant in each task with the exclusion of responses made faster than 200 ms. The data were cleaned by removing RTs that were more than 3 standard deviations outside the mean for each condition. This eliminated less than 1% of the trials overall. D-prime (*d'*) (Green & Swets, 1966) was calculated for each participant to determine sensitivity in discriminating correct and incorrect shape-based associations across both match and mismatch shape based associations. The electrophysiological results are reported under subheadings of different ERP components – N1, P300, N2 – and each subheading discusses findings from the reward and social tasks based on shape, respectively.

Questionnaire analyses are reported in Chapter 7. Bonferroni correction was applied for multiple comparisons (Holm, 1979) in paired-samples t-tests.

6.3. Results

6.3.1. Behavioural data

6.3.1.1. RTs in match trials

A repeated measures ANOVA was performed on the match trials reaction times. Two within-subject variables were used, task (reward or social) and shape-label association (self, mother, friend, acquaintance, stranger or 1, 3, 5, 7, 9). Results showed a significant main effect of shape-label association, $F(4, 108) = 12.10$, $p < .001$, $\eta^2 = .31$, but not task, $F(1, 27) = 2.81$, $p = .11$, $\eta^2 = .09$. There was also a significant interaction between task and shape-label association, $F(4, 108) = 16.16$, $p < .001$, $\eta^2 = .37$, *see Table 17*.

Table 17. Mean RTs (ms) and SDs (in brackets) for match trials as a function of task and association.

Reward associations	Mean RTs (ms)	Social associations	Mean RTs (ms)
9x	487 (79)	Self	480 (90)
7x	500 (82)	Mother	504 (94)
5x	503 (76)	Friend	514 (88)
3x	495 (76)	Acquaintance	538 (90)
1x	480 (72)	Stranger	533 (89)
Mean	493 (77)	Mean	514 (92)

To decompose this interaction, reward and social tasks were analysed individually using repeated measures ANOVAs with one within-subjects variable – shape-label association. In the reward task, a significant main effect of shape association was found, $F(4, 108) = 5.52$, $p < .001$, $\eta^2 = .17$, *see Figure 23.* Paired samples t-tests were performed to compare the differences in RTs between each of the reward value with the highest value 9x. Consistent with the ERP results, this revealed that the responses to the high reward 9x was significantly faster than the responses to 5x, $t(27) = -3.05$, $p = .005$, $dz = .21$,. However, responses to 9x were similar to the other associations – 1x, $t(27) = 1.03$, $p = .311$, $dz = .09$, 3x, $t(27) = -1.25$, $p = .222$, $dz = .10$, and 7x $t(27) = -1.98$, $p = .058$, $dz = .16$.

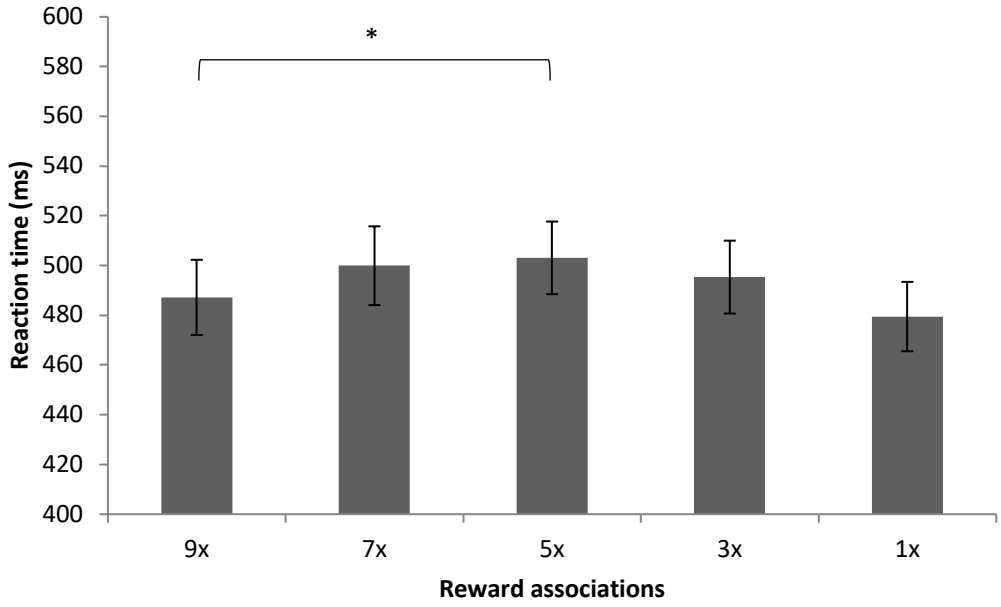


Figure 23. RTs on match trials in the reward task as a function of shape association. Error bars represent one standard error. Significant differences between associations are marked with ''.*

In the social task, a significant main effect of shape-label association was found, $F(4, 108) = 18.80$, $p < .001$, $\eta^2 = .41$, *see Figure 24.* Paired samples t-tests revealed that the RTs for the self association were significantly faster than RTs for the mother association, $t(27) = -3.38$, $p = .002$, $dz = .26$, friend association, $t(27) = -4.71$, $p < .001$, $dz = .38$, acquaintance association, $t(27) = -8.60$, $p < .001$, $dz = .64$, and stranger association, $t(27) = -6.53$, $p < .001$, $dz = .59$.

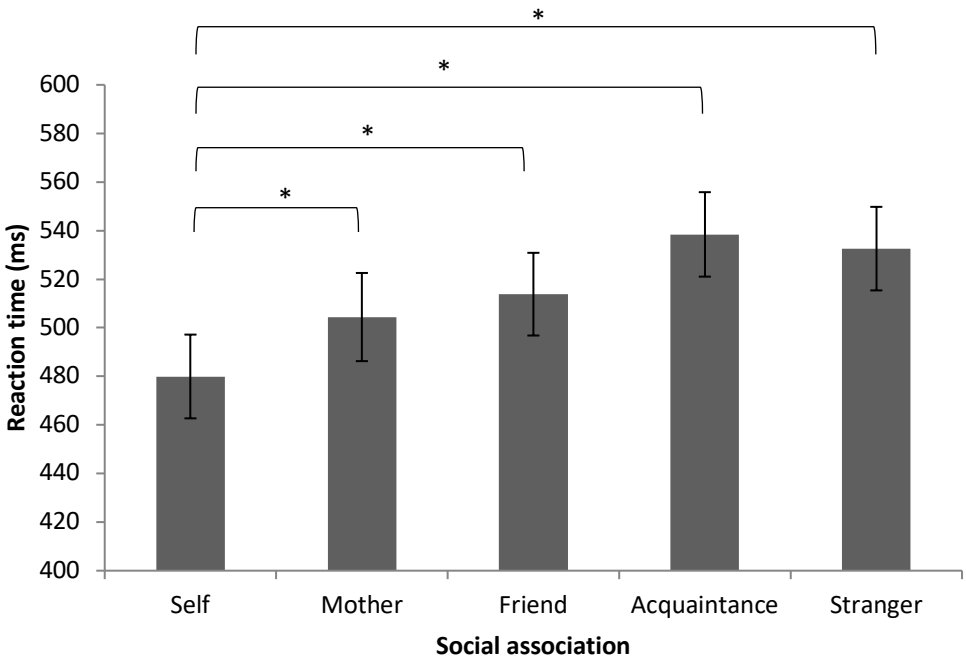


Figure 24. RTs on match trials in the social task as a function of shape association. Error bars represent one standard error. Significant differences between associations are marked with ''.*

6.3.1.2. D-prime

D-prime was calculated for each of the associations. A repeated measures ANOVA found a significant main effect of task (reward or self), $F(1, 27) = 26.27$, $p < .001$, $\eta^2 = .49$, but not shape-label association (self, mother, friend, acquaintance, stranger or 1, 3, 5, 7, 9), $F(4, 108) = 1.48$, $p = .21$, $\eta^2 = .05$. Pairwise comparison on the tasks indicated that the reward task had a significantly higher overall d-prime than the social task ($p < .001$), *see Table 18*. No interaction was found between task and shape-label association, $F(4, 108) = 1.13$, $p = .35$, $\eta^2 = .04$.

Table 18. Mean d-prime and SDs (in brackets) as a function of task and association.

Reward associations	D-prime	Social associations	D-prime
9x	4.57 (.97)	Self	4.14 (1.09)
7x	4.52 (.98)	Mother	3.87 (.90)
5x	4.62 (1.11)	Friend	3.85 (.87)
3x	4.53 (.90)	Acquaintance	3.67 (.95)
1x	4.75 (1.19)	Stranger	3.92 (.84)
Mean	4.60 (1.03)	Mean	3.89 (.93)

6.3.1.3. Correlation analyses

Correlation analyses were conducted to examine the relationship between the behavioral responses and the questionnaire measures. Please see Chapter 7 for the results.

6.3.2. Electrophysiological data

6.3.2.1. N1 component

The N1 component was measured as the mean voltage between 100 – 150 ms after stimulus onset. In this study, the N1 was maximal at the occipital sites and so the channels Oz, O1, and O2 were averaged together, *see Figure 25 and Table 19*. A repeated measures ANOVA was performed with two within-subject variables – task (reward or social) and shape (self, mother, friend, acquaintance, stranger or 1, 3, 5, 7, 9). The analyses revealed no main effect of task, $F(1, 27) = 2.85$, $p = .10$, $\eta^2 = .10$, nor shape, $F(4, 108) = 2.07$, $p = .09$, $\eta^2 = .07$. However, a significant interaction was found between task and shape, $F(4, 108) = 3.69$, $p < .05$, $\eta^2 = .12$, *see Table 20*.

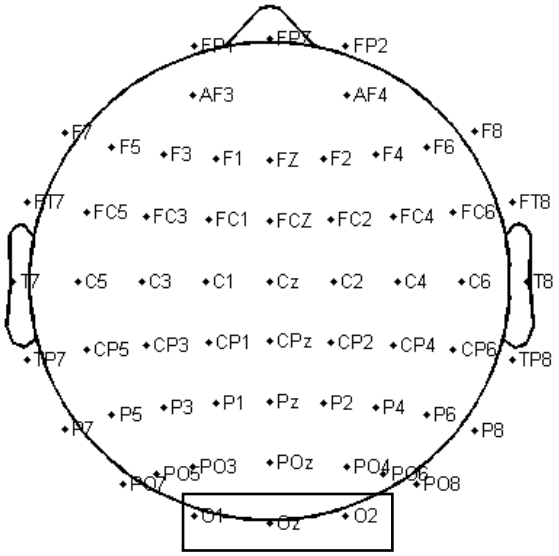


Figure 25. Map of the electrode locations. The box indicated the sites where the electrodes were averaged together to calculate the N1 component.

Table 19. Topographic map of N1 for reward and social associations with a view of the occipital regions of the head.

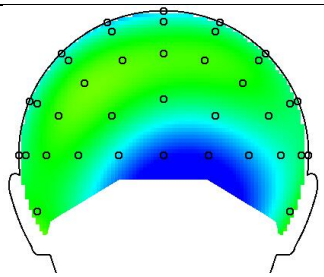
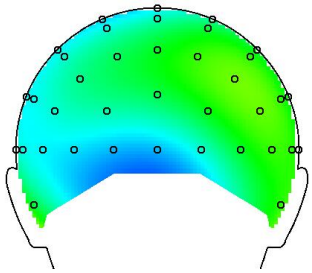
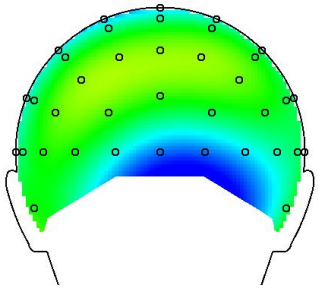
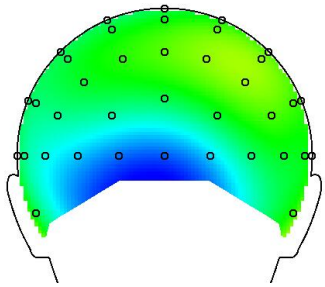
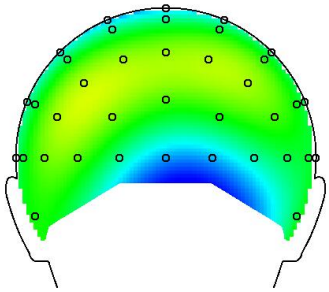
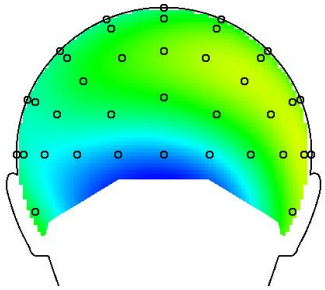
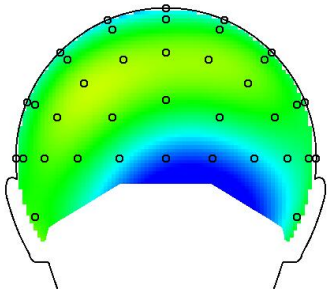
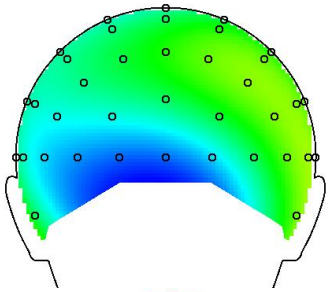
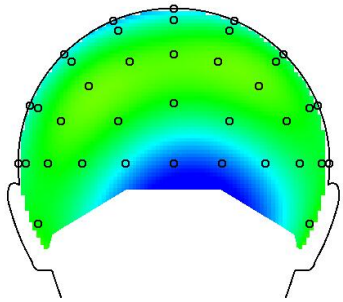
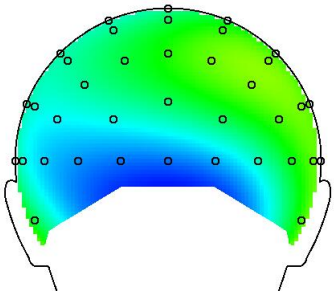
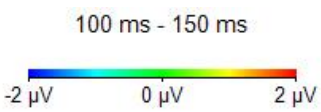
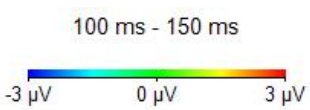
N1	Reward		Social
9x		Self	
7x		Mother	
5x		Friend	
3x		Acquaintance	
1x		Stranger	
			

Table 20. Mean voltage (μV) and SDs (in brackets) as a function of shape.

Reward associations	Mean voltage (μV)	Social associations	Mean voltage (μV)
9x	-1.83 (2.88)	Self	-1.89 (2.67)
7x	-1.49 (2.88)	Mother	-2.46 (2.55)
5x	-1.27 (2.79)	Friend	-2.05 (2.86)
3x	-1.58 (2.81)	Acquaintance	-2.28 (2.66)
1x	-1.60 (2.92)	Stranger	-2.23 (2.67)
Mean	-1.55 (2.82)	Mean	-2.18 (2.65)

The interaction between task and shape was decomposed by analysing the two tasks separately. In the reward task, a repeated measures ANOVA with shape as a factor revealed a significant main effect, $F(4, 108) = 3.10$, $p < .05$, $\eta^2 = .10$, *see Figures 26 and 27*. Paired samples t-tests compared the high reward value 9x with each of the lower reward values. After Bonferroni correction, the high reward 9x elicited increased voltage when compared with the value 5x, $t(27) = -2.81$, $p = .009$, $dz = .20$. However, no significant differences were found between the mean voltage between the high reward 9x and the other reward values – 1x, $t(27) = -1.25$, $p = .222$, $dz = .08$, 3x, $t(27) = -1.94$, $p = .063$, $dz = .09$, and 7x, $t(27) = -2.37$, $p = .025$, $dz = .12$. Again, an inverted U-shape distribution of the voltage for each shape condition was observed, *see Figure 27.*

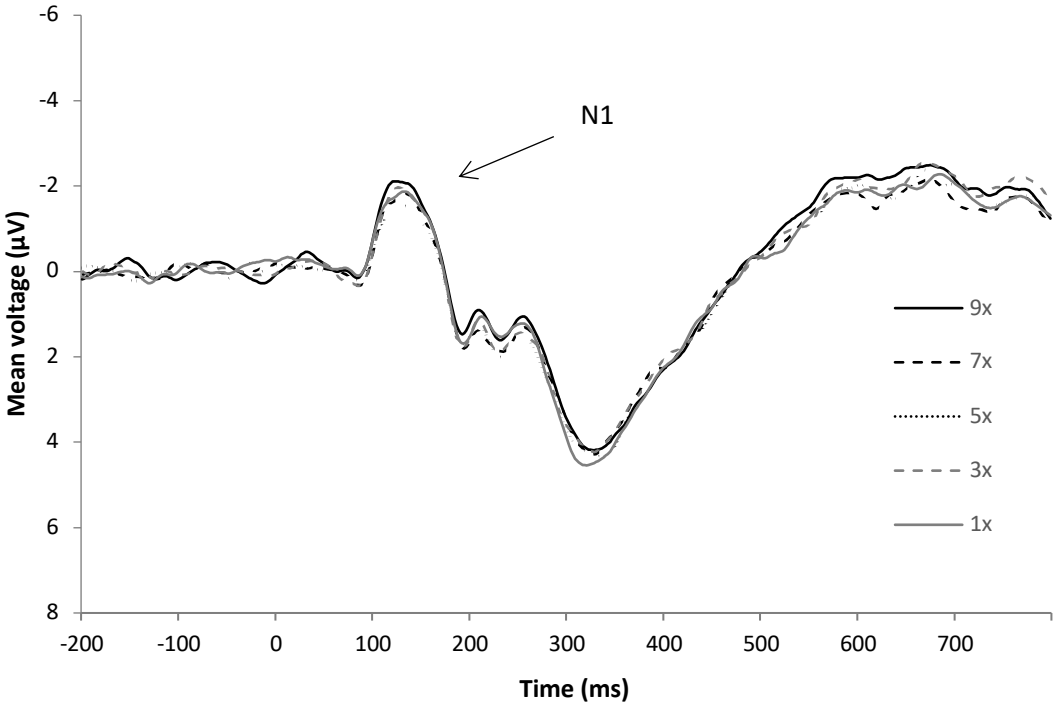


Figure 26. Mean voltage for the N1 component, calculated using the average of the channels Oz, O1, and O2, as a function of shape in the reward task.

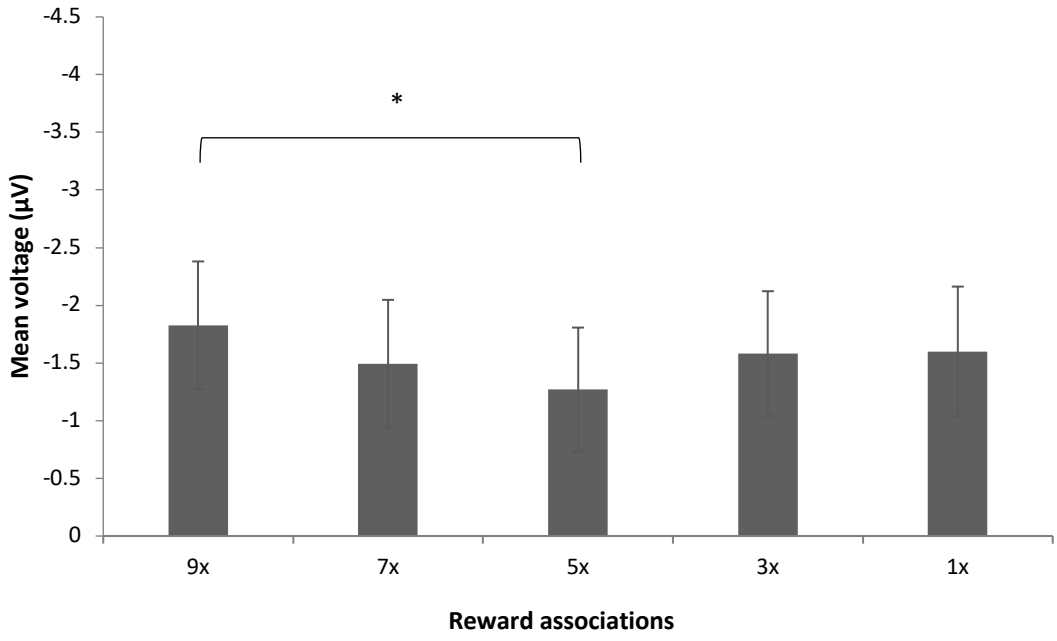


Figure 27. Mean N1 amplitude on match trials in the reward task as a function of shape. Error bars represent one standard error. Significant differences between associations are marked with ''.*

In the social task, the same analyses were also performed. A repeated measures ANOVA found a significant main effect of shape, $F(4, 108) = 3.09$, $p < .05$, $\eta^2 = .10$, *see Figures 28 and 29*. Paired samples t-tests revealed decreased voltage for the self shape when compared with the mother shape, $t(27) = 3.00$, $p = .006$, $dz = .22$. No significant differences were found, after Bonferroni correction, between the self shape and the other shapes – friend, $t(27) = .86$, $p = .399$, $dz = .06$, acquaintance, $t(27) = 2.20$, $p = .037$, $dz = .15$, and stranger, $t(27) = 1.86$, $p =. 074$, $dz = .13$.

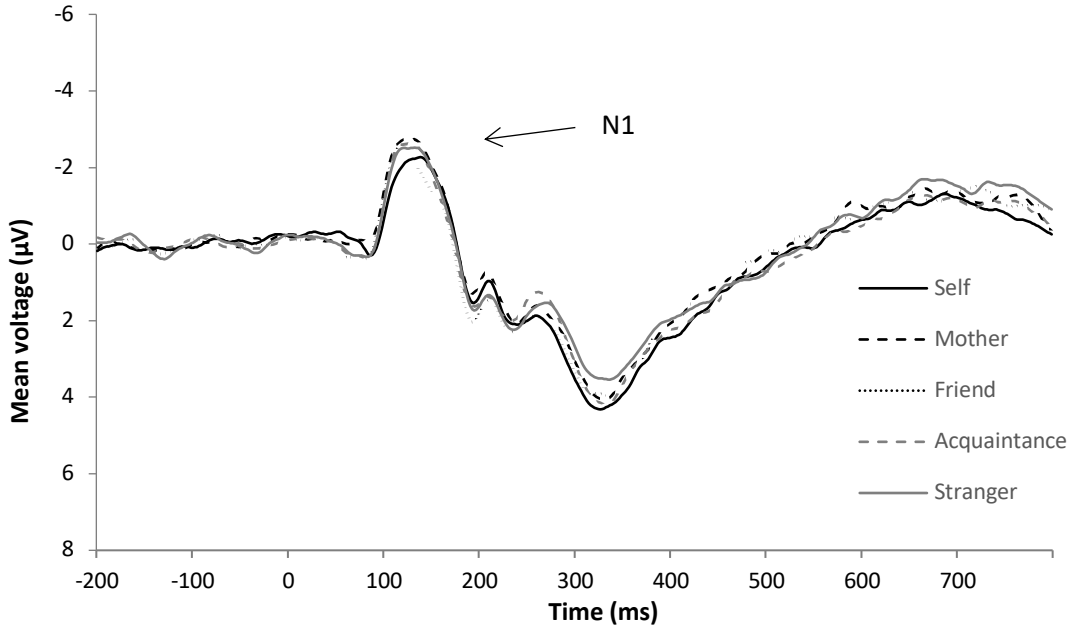


Figure 28. Mean voltage for the N1 component, calculated using the average of the channels Oz, O1, and O2, as a function of shape in the social task.

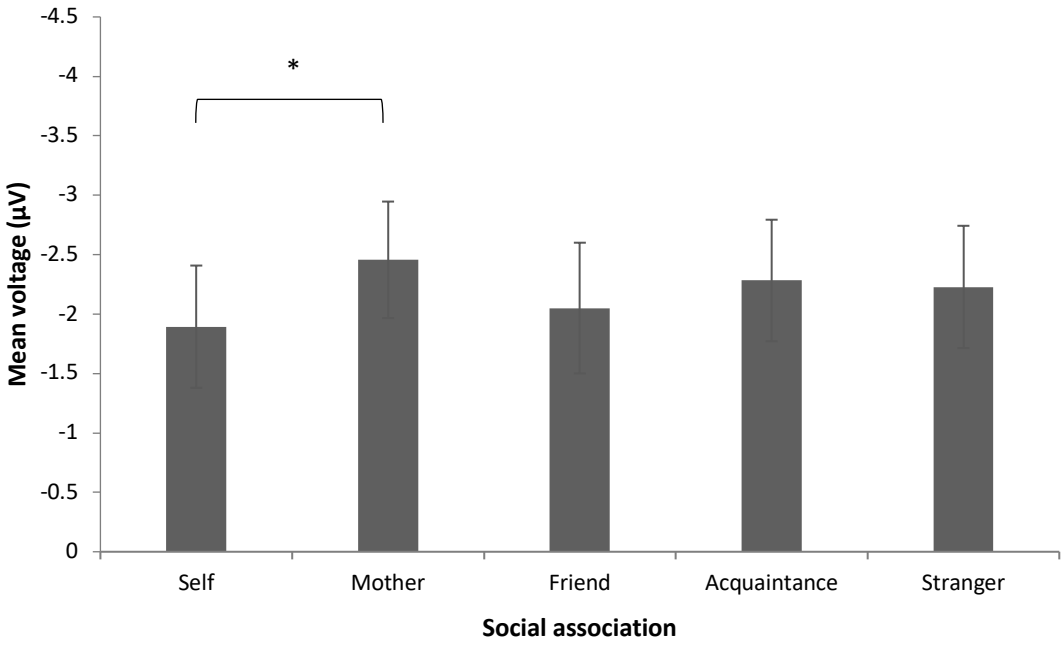


Figure 29. Mean N1 amplitude on match trials in the social task as a function of shape. Error bars represent one standard error. Significant differences between associations are marked with ''.*

6.3.2.2. P300 component

In this study, the P300 component was measured as the mean voltage between 300 - 400 ms after stimulus onset. The P300 was maximal at the posterior midline sites and the channels – Cz, CPz, Pz, POz,– were averaged together, *see Figure 30 and Table 21*. A repeated measures ANOVA was performed using task (reward or social) and shape (self, mother, friend, acquaintance, stranger or 1, 3, 5, 7, 9) as the within-subject variables. This revealed a significant main effect of task, $F(1, 27) = 6.25$, $p < .05$, $\eta^2 = .19$, as well as shape, $F(4, 108) = 5.11$, $p < .01$, $\eta^2 = .16$. The overall mean voltage of the P300 in the reward task was higher than the social task ($p < .05$), *see Table 22*.

Pairwise comparison showed that voltage in response to the self shape and the high reward 9x was significantly larger than the voltage for friend and 5x ($p < .05$), as well as for acquaintance and 3x ($p < .05$), *see Table 22*. Most importantly, there was a significant interaction between task and shape, $F(4, 108) = 6.79$, $p < .001$, $\eta^2 = .20$, *see Table 22*.

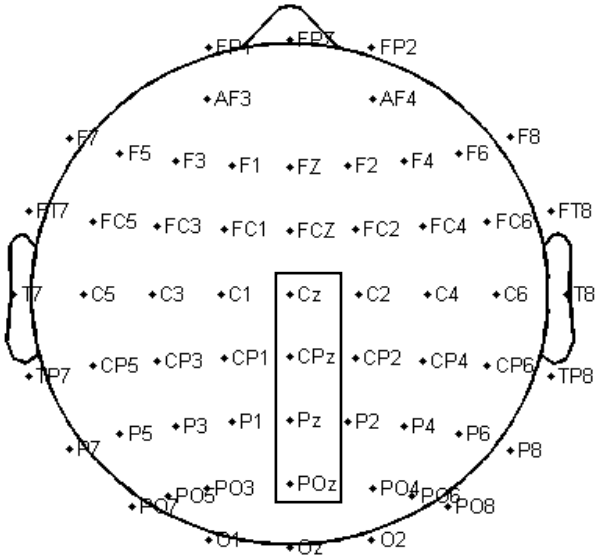


Figure 30. Map of the electrode locations. The box indicated the sites where the electrodes were averaged together to calculate the P300 component.

Table 21. Topographic map of P300 for reward and social associations.

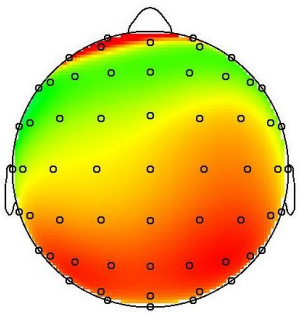
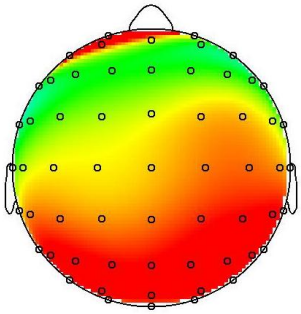
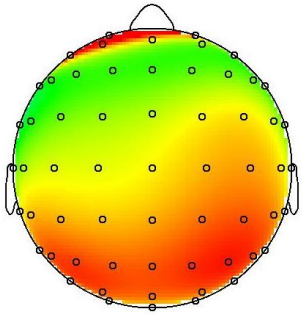
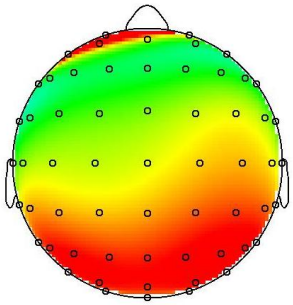
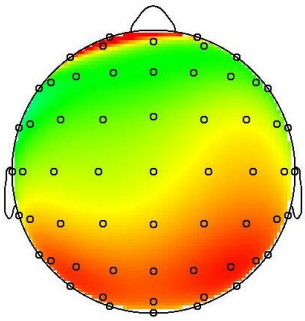
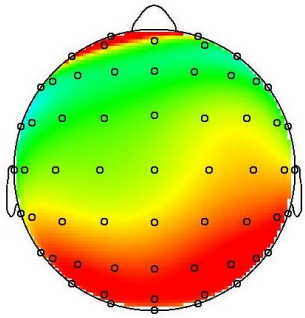
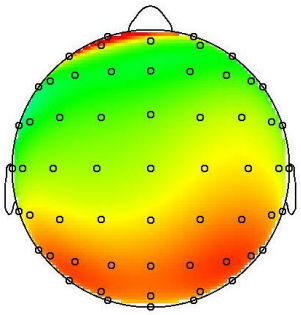
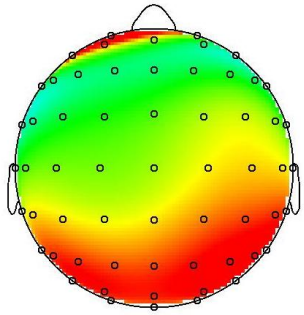
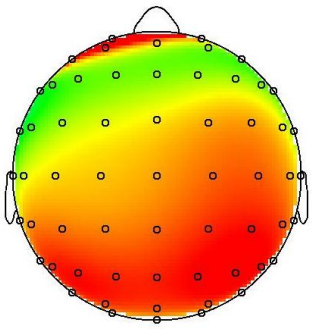
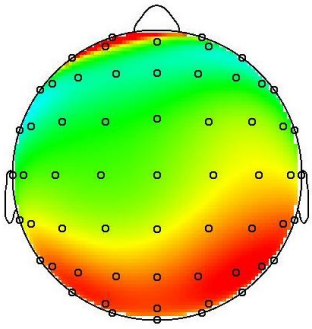
P300	Reward		Social
9x		Self	
7x		Mother	
5x		Friend	
3x		Acquaintance	
1x		Stranger	
	300 ms - 400 ms -7 µV 0 µV 7 µV		300 ms - 400 ms -5 µV 0 µV 5 µV

Table 22. Mean voltage (μV) and SDs (in brackets) as a function of shape.

Reward associations	Mean voltage (μV)	Social associations	Mean voltage (μv)
9x	5.09 (3.72)	Self	4.04 (3.52)
7x	4.69 (3.67)	Mother	3.57 (3.16)
5x	4.42 (4.04)	Friend	3.27 (3.28)
3x	4.07 (3.60)	Acquaintance	3.09 (3.83)
1x	5.51 (3.85)	Stranger	2.66 (3.50)
Mean	4.76 (3.76)	Mean	3.33 (3.45)

To decompose this interaction, the voltage for the reward and social tasks were analysed separately. An ANOVA performed on the reward task P300 amplitudes revealed a significant main effect of shape, $F(4, 108) = 8.14$, $p < .001$, $\eta^2 = .23$, *see Figure 31 and 32*. Paired samples t-tests compared the high reward value 9x to each of the other associations. After bonferroni correction, it was found that the mean voltage in response to the high reward value 9x was significantly higher than the voltage for the reward values 3x, $t(27) = 4.35$, $p < .001$, $dz = .28$, and 5x, $t(27) = 2.64$, $p = .014$, $dz = .17$, but was similar to the voltage for the reward values 1x, $t(27) = 1.37$, $p = .181$, $dz = .11$, and 7x, $t(27) = -1.49$, $p = .149$, $dz = .11$. This resulted in an inverted U-shape distribution of voltage for each shape condition, *see Figure 32*.

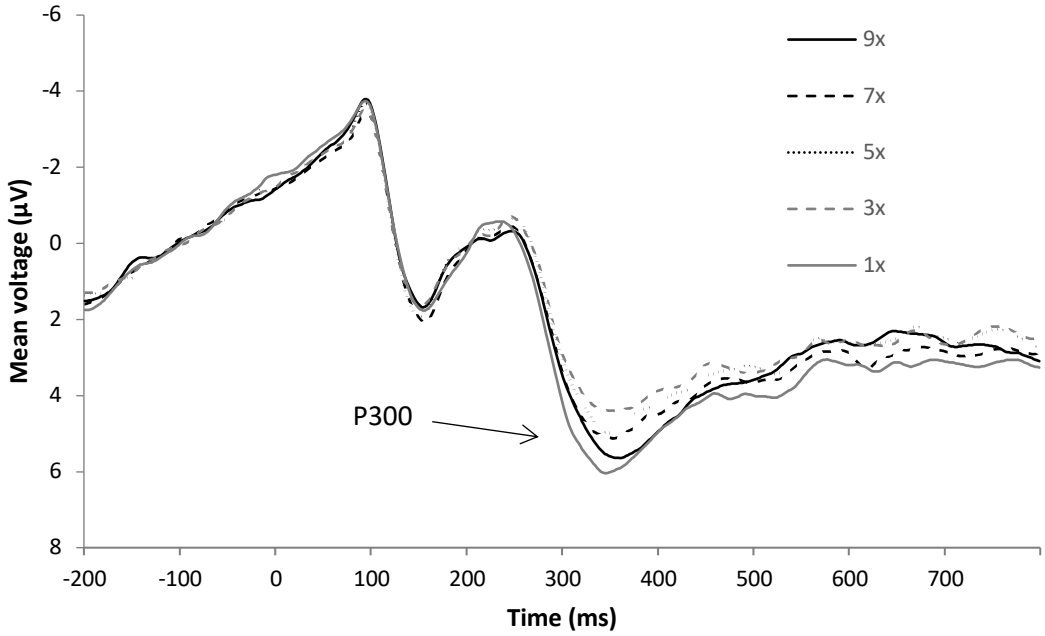


Figure 31. Mean voltage for the P300 component, calculated using the average of the channels Cz, CPz, Pz, POz, as a function of shape in the reward task.

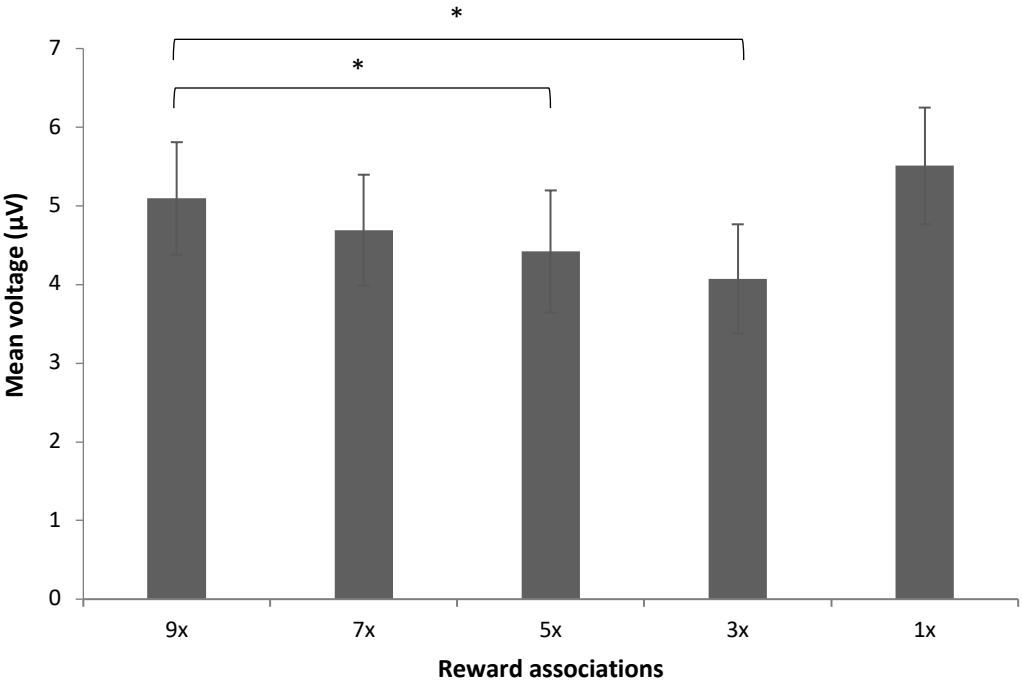


Figure 32. Mean P300 amplitude on match trials in the reward task as a function of shape. Error bars represent one standard error. Significant differences between associations are marked with ''.*

An ANOVA performed on the social task also revealed a significant main effect of shape, $F(4, 108) = 4.46$, $p < .01$, $\eta^2 = .14$, *see Figure 33 and 34*. Paired samples t-tests revealed significantly higher voltage in response to the self shape than stranger shape, $t(27) = 3.57$, $p = .001$, $dz = .39$. However, the self shape was not significantly different in voltage to the other shapes – mother, $t(27) = 1.37$, $p = .182$, $dz = .14$, friend, $t(27) = 2.16$, $p = .040$, $dz = .23$, and acquaintance, $t(27) = 2.38$, $p = .024$, $dz = .26$, – after Bonferroni correction.

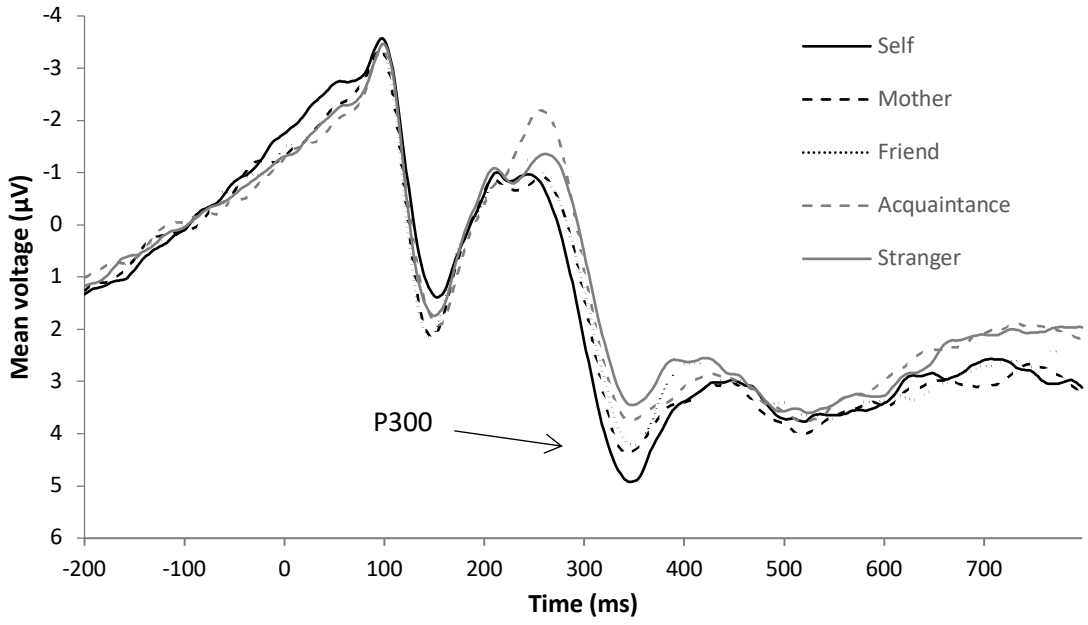


Figure 33. Mean voltage for the P300 component, calculated using the average of the channels Cz, CPz, Pz, POz as a function of shape in the social task.

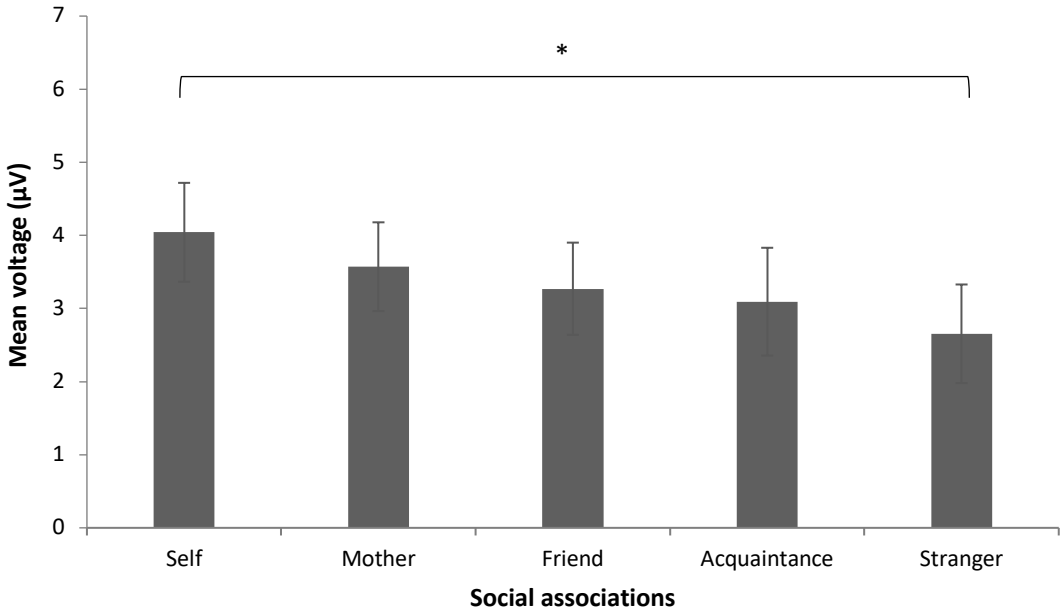


Figure 34. Mean P300 amplitude on match trials in the social task as a function of shape. Error bars represent one standard error. Significant differences between associations are marked with ''.*

6.3.2.3. Anterior N2 component

The N2 component was averaged over 210 – 280 ms after stimulus onset. Midline channels – Fz, FCz, Cz – were averaged together for the analyses, *see Figure 35 and Table 23*. A repeated measures ANOVA was performed using two within-subject variables – task (reward or social) and shape (self, mother, friend, acquaintance, stranger or 1, 3, 5, 7, 9). Results showed a significant main effect of shape, $F(4, 108) = 4.93$, $p = .001$, $\eta^2 = .15$, but not task, $F(1, 27) = 3.92$, $p = .06$, $\eta^2 = .13$, *see Table 24*. Pairwise comparisons showed that N2 amplitude in response to the self and 9x shapes were lower than the responses to acquaintance and 3x shapes ($p < .05$) but were similar to the other shapes – mother and 7x ($p = 1.00$), friend and 5x ($p = .39$), stranger and 1x

(p = 1.00). However, no significant interaction between task and shape was found, F(4, 108) = 1.40, p = .24, η^2 = .05, *see Table 24, Figures 36 and 37*.

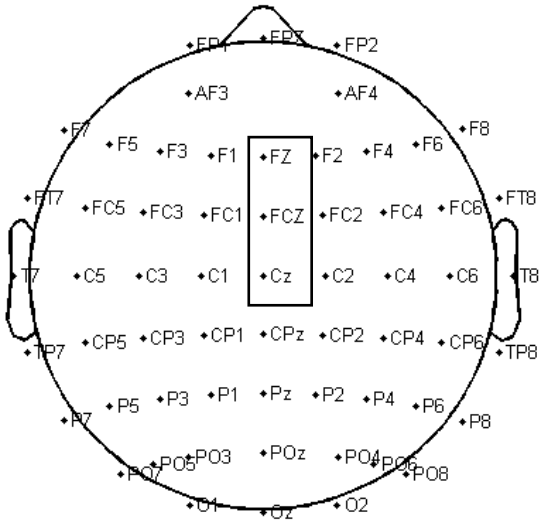


Figure 35. Map of the electrode locations. The box indicated the sites where the electrodes were averaged together to calculate the N2 component.

Table 23. Topographic map of N2 for reward and social associations.

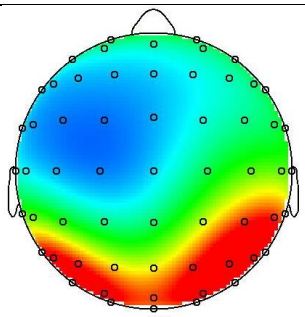
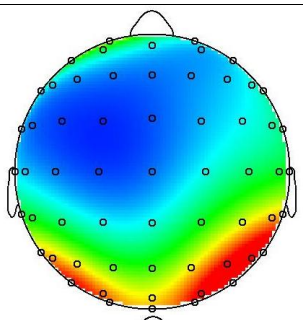
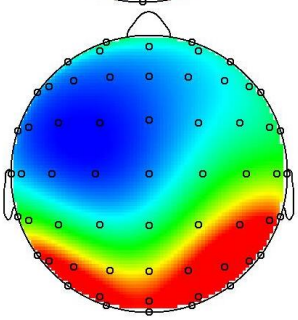
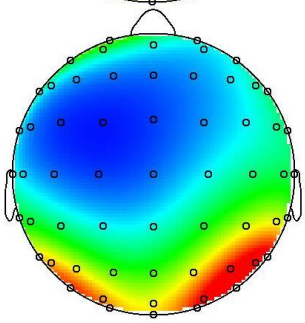
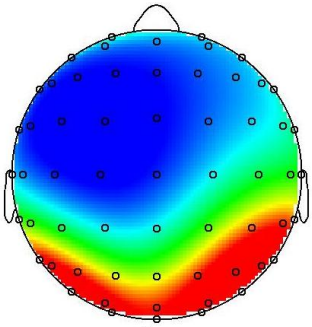
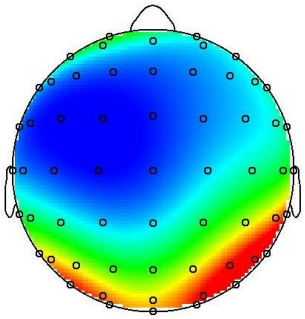
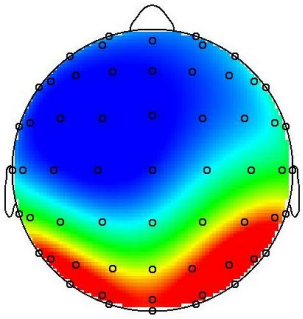
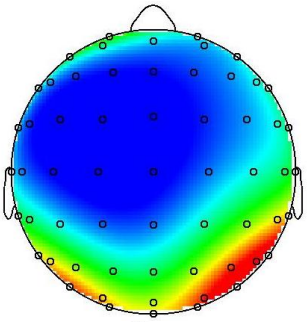
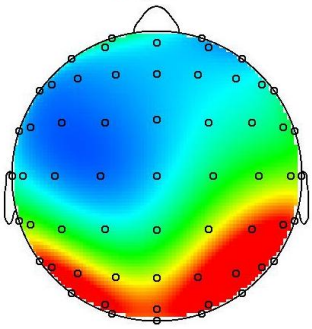
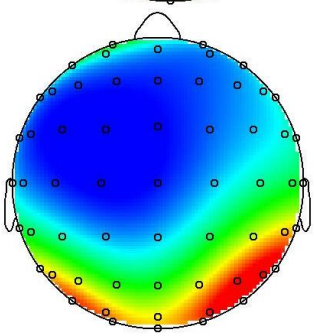
N2	Reward		Social
9x		Self	
7x		Mother	
5x		Friend	
3x		Acquaintance	
1x		Stranger	
	210 ms - 280 ms -2 µV 0 µV 2 µV		210 ms - 280 ms -3 µV 0 µV 3 µV

Table 24. Mean voltage (μV) and SDs (in brackets) as a function of shape.

Reward associations	Mean voltage (μV)	Social associations	Mean voltage (μV)
9x	-1.25 (5.42)	Self	-2.49 (4.22)
7x	-1.60 (4.16)	Mother	-2.50 (4.21)
5x	-1.99 (4.62)	Friend	-2.77 (3.69)
3x	-2.07 (4.26)	Acquaintance	-3.39 (3.74)
1x	-1.27 (4.74)	Stranger	-3.00 (3.65)
Mean	-1.63 (4.61)	Mean	-2.83 (3.87)

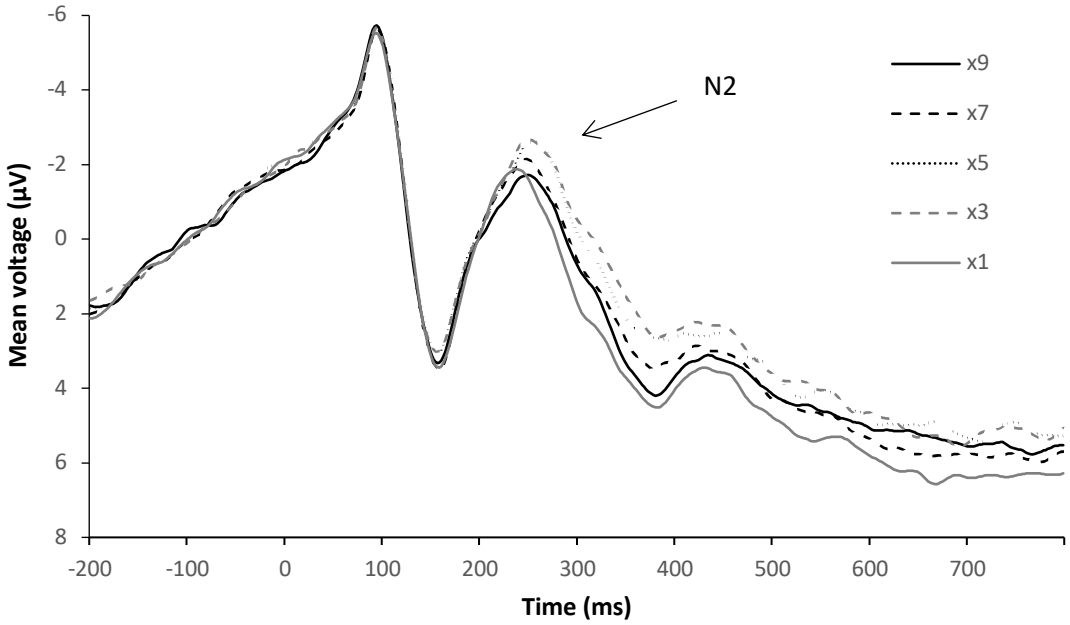


Figure 36. Mean voltage for the N2 component, calculated using the average of the channels Fz, FCz, and Cz, as a function of shape in the reward task.

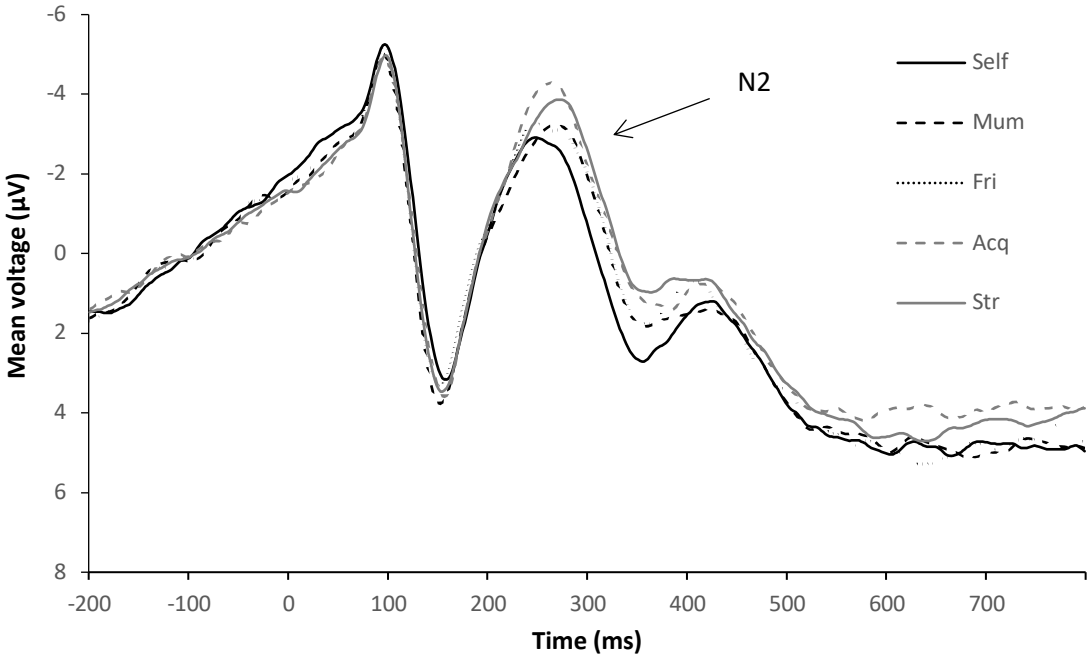


Figure 37. Mean voltage for the N2 component, calculated using the average of the channels Fz, FCz, and Cz, as a function of shape in the social task.

6.4. Discussion

Previously, ERP components such as the N1 and P300 have been found to be sensitive to attention and the significance of the stimuli, while the N2 was associated with perceptual salience. Additionally, the amplitudes of these components were also found to be modulated by self-related information and reward stimuli. In line with these findings, the current study compared the electrophysiological measures of self and reward processes in perceptual matching tasks. The hypothesis was that self-related stimuli and high reward stimuli, which are stimuli high in significance, would enhance the amplitudes of the N1, P300 and N2 due to automatic attentional capture.

6.4.1. Findings and implications

The behavioural and ERP results are discussed in conjunction for each of the reward and social tasks. In the reward task, the highest amplitudes in both N1 and P300 were elicited by the highest reward 9x and the lowest reward 1x, with minimal difference between the two values. Though increased N1 and P300 amplitude in response to higher reward was expected due to higher motivational significance and stronger attentional capture, these results contradicted previous studies that explained the magnitude of the value as more motivationally significant (Sato et al., 2005; van den Berg, Krebs, Lorist, & Woldorff, 2014; Yeung & Sanfey, 2004). Additionally, the lowest amplitude was elicited by the moderate reward 5x, which resulted in an inverted U-shaped distribution in both N1 and P300. Similar inverted U-shape distributions were also found in the behavioural RTs as well as the results from the previous chapter (*see Chapter 5*), where the highest and the lowest reward produced the fastest RTs but moderate reward was slowest.

This may be explained by a few possibilities. First, this may be due to high task demand, where 5 shape and label pairs were difficult to memorise. As previously explained in Chapter 5, the participant may have focused on utilising the lowest and highest reward values as anchors for memorising the associations rather than means of monetary gain. Second, the participants may have begun to categorise the associations to facilitate better performance. For example, the two extreme values 1x and 9x were put into the same category with the middle values in another category. Third, it is also possible that the low reward 1x was perceived as more important due to the presentation of the stimuli. The value of the other shapes was introduced as multiples of 1x, which may have reinforced the participants into thinking that 1x was the foundation to all other associations. Hence, 1x may have been encoded and perceived differently

from the other reward values. These explanations may also be applied to the inverted U-shaped distribution in Chapter 5.

The results in the social task were less consistent between N1 and P300. Though the P300 reflected the monotonic pattern of the behavioural results, the N1 showed decreased voltage in response to the self shape but increased voltage to the mother shape, which was different from previous research that found larger N1 in response to more socially significant stimuli (e.g. Foti, Hajcak, & Dien, 2009; Liu, He, & Sui, 2015; Plihal, et al., 2001). A possible explanation for this is that self-related stimuli automatically attract attention (e.g. Alexopoulos, Muller, Ric, & Marendaz, 2012; Bargh, 1982) which means it requires less attention and can be processed faster than other stimuli. As a result, self-related stimuli may elicit reduced neural response due to its automatic attention capture. This would also explain why the mother shape showed the largest voltage because the mother stimulus was the most significant stimuli besides the self. However, mother stimuli do not automatically attract attention like self-related stimulus and could not be processed with less attention and faster speed. Thus, the mother stimuli elicited the increased neural response in N1 due to its highest significance compared with friend, acquaintance, and stranger stimuli.

In contrast, P300 amplitude was highest for the self and lowest for the stranger shape. This finding was consistent with previous studies that explained self-related stimuli was processed with higher levels of attention due to the perceived significance of the stimuli (Gray, 2004; Tacikowski & Nowicka, 2011). This was further reflected by the gradient of the distribution of the RTs in both the present study and the previous chapter (*see Chapter 5*) – the gradual increase of the RTs from most self-related to least self-related corresponded with the gradual decrease in the P300 amplitudes from most self-related to least self-related. In conjunction with the P300 amplitudes, the pattern of

the behavioural results can be explained by the varying levels of attentional resources involved in producing the responses for each condition.

The pattern of the behavioural results also matched with the pattern for the P300 results. Both results demonstrated a U-shape distribution (U-shape for behavioural results and inverted U-shape for ERP results) in the reward task. Whereas, a monotonic trend (increase for behavioural and decrease for ERP results) was observed in the social task. The differences between 9x and 5x, and between self and stranger, were significantly different in both the behavioural results and the results from P300. In both cases, the ERP results provided better temporal information on the cognitive processes.

Although the N2 component was analysed due to its association with perceptual salience, no significant differences were found between the shape-label associations within each task and thus was unable to provide information on self and reward processes in this study. Further testing will be needed to study perceptual salience in the processing of self and reward stimuli.

The d-prime results showed that sensitivity for reward was higher than sensitivity for personal labels in this particular study. It may be explained that the prospect of reward encouraged higher sensitivity than personal labels in the Chinese participants. However, if this was the case, then the high reward 9x should also demonstrate the highest d-prime value. Instead, the results showed that, numerically, the highest d-prime value was in response to the lowest reward 1x. Though the differences were minimal, no significant differences were found between the d-prime values for the high or low reward associations. Thus, it is unclear what motivated the higher sensitivity for reward associations and future research may investigate this further.

Going beyond the behavioural measures, the present study provided evidence that parallel comparisons of self and high reward demonstrated differential processes. Specifically, it appeared that self-related stimulus was processed with advantage over other stimuli (including reward-related stimuli) in two ways. First, the self may be viewed as a perceptual default which can be processed with little attentional resources (as demonstrated with the reduced N1 amplitudes). Whereas, high reward stimulus required more attention (as shown by increased N1 amplitudes) than other reward stimuli. This contrast between self and reward was observed in early visual attention around 100 – 150 ms after stimuli onset. Second, the self may be treated as more motivationally significant than other stimuli (supported by the increased P300 amplitudes). In contrast, both low and high reward stimuli were perceived as the most motivationally significant (both showed increased P300 amplitudes). This difference occurred in later time course around 300 – 400 ms after stimuli onset. The advantages demonstrated by the self stimulus over other stimuli may partially explain the robustness of the self bias effect, as well as provide evidence that self-related information and high reward share partially differential processes. More research is required to fully understand what other factors also contribute to the self bias effect.

Closer inspection of the behavioural results between this chapter and the previous chapter (Chapter 5) also reveal some differences between self and mother associations. This could potentially be a result of cultural differences between the participants (British in Chapter 5 and Chinese in Chapter 6). However, the experiment procedure was different between the previous chapter and this chapter. Chapter 5 presented both shape and label stimuli simultaneously on the screen whilst the current chapter presented the shape and label stimuli in sequential order. Thus, it may not be appropriate to make parallel comparisons between the two studies. Moreover, this is

outside the scope of this part of the thesis as the aim of Chapters 5 and 6 was to investigate the relationship between self and reward processes.

6.4.2. Significance of this study

The current study is the first time the ERP technique is used to study the self and reward processes with the perceptual matching paradigm. Though previously, self and reward processes have been studied in a similar fashion using fMRI (Yankouskaya et al., 2017), the ERP technique provides higher temporal resolution and studies the self bias effect from the entire brain (as opposed to the prefrontal cortex). The current study builds on the results from the previous chapter (Chapter 5) and furthers the understanding of the underlying mechanisms of the self bias effect by combining the behavioural and electrophysiological measures. The combination of the two techniques allowed the examination of self and reward processes from a new perspective and adds more findings to existing research.

6.4.3. Limitations and future research

The inverted U-shaped distribution of the reward results, in this study, may be due to the five shape-label associations being taxing on memory, as was explained in the findings and implications section (*see 6.4.1.)*. The difficulty of the current task may have caused more cognitive resources to be attributed to memorising the correct associations rather than focusing on the potential gain of the monetary reward in the reward task. This in turn may have reduced the perceived motivational significance of high reward. Future studies should carefully consider the number of stimuli used to avoid overdemand of cognitive resources.

Future studies on the relationship between self and reward processes should be aware that reward is constantly changing as a result of society (Kringelbach & Berridge, 2009). Moreover, reward can take many forms other than monetary gain. For example, people from underdeveloped countries may consider food and clean water more rewarding while people from developed countries may consider luxury experiences (e.g. fine dining, theatrical performances, travel) as more rewarding. The definition of reward varies as a result of different factors such as socio-economic status and societal developments. Thus, researchers may consider studying other types of reward (e.g. social rewards) in combination with the self bias effect.

In conclusion, this study employed the ERP technique to further investigate the cognitive processes underlying self and reward processes. Specifically, the early visual attention N1 differentiated between self and mother shapes in the social task, and between high and moderate reward in the reward task. Later on, the P300 demonstrated that self-related information and both low and high reward received preferential access to attentional resources due to the perceived significance of these stimuli. These findings are consistent with the parallel processing model proposed by (Northoff & Hayes (2011). This chapter confirmed the results from the previous chapter (*see Chapter 5*) that the self bias effect cannot be fully explained by higher intrinsic value associated with self-related information.

Chapter 7

Correlation analyses between the self bias effect and self-reported questionnaire measures

Abstract

This chapter uses a cross-disciplinary approach in psychology to study the self bias effect through social and experimental psychology methods to better understand the nature of the self. A series of self-reported questionnaires traditionally used in social psychology was analysed in conjunction with the behavioural data from previous chapters. The results demonstrated no significant correlations. There was, however, a negative correlation between the normalised reward RTs (between 9x and 3x) and normalised self RTs (between self and stranger), which suggested separate processes underlying reward and self processes. By incorporating questionnaires from social psychology methods, the current chapter attempted to study the self bias effect from a different perspective. These findings should provide inspiration and motivation to examine the self bias effect through multiple approaches in future research.

Keywords: self bias, self construal, self-esteem, reward sensitivity, personal distance

7.1. Introduction

The previous chapters investigated the modulation of the self bias effect (*see Chapters 2, 3 & 4)* as well as the underlying mechanisms of self bias (*see Chapters 5 & 6*). Self-reported questionnaires were collected along with the behavioural data from each of the chapters. In this chapter, the behavioural data for the self and reward bias in the perceptual matching task and the questionnaire measures were correlated. The goal of this chapter was to use cross-disciplinary methods in psychology to examine the self bias effect – self-reported questionnaires as a social psychology measure in contrast to the behavioural measures from an experimental psychology perspective. The following section will briefly introduce each of the questionnaires used throughout the entire thesis. All questionnaires used throughout the thesis are included in the Appendix.

7.1.1. Questionnaires

Questionnaires were implemented to measure the relationship between personal traits and behavioural responses. The following questionnaires were administered in the previous chapters: Self Construal Scale (Singelis, 1994), Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995), Rosenberg Self-Esteem Scale (Rosenberg, 1965), Self-Monitoring Scale (Snyder, 1974), Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988), the Sensitivity to Reward Scale from Sensitivity to Punishment and Sensitivity to Reward Scale (Torrubia et al., 2001), Behavioural Activation System (Carver & White, 1994), and Personal Distance Scale (Sui & Humphreys, 2015), *see Appendix A*.

7.1.1.1. Self construal questionnaires

To measure self-construal styles, the Self Construal Scale (Singelis, 1994) and the Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995) were administered in Chapters 2 and 3, *see Appendices A.1 and A.2*. The goal of this was to examine whether the participants demonstrated self construal styles that correlated with the magnitude of the self bias (both relative to friend and relative to stranger).

The Self Construal Scale was developed by Singelis (1994) to measure the thoughts, feelings and actions that constitute independent and interdependent self construals. The focus of the scale was on the relationship between self and others and to measure the extent of which the self is perceived as separated or connected with others (Markus & Kitayama, 1991). The elements that define independent self focuses on one's own achievements, attributes, and goals rather than that of others. In contrast, interdependent self is characterised by a sense of connectedness with others and an intertwined relationship between self with others. The scale consists of 24 items – 12 items measuring independence and 12 items measuring interdependence. Each of the items describes a social scenario with an independent or interdependent outcome. Participants responded by indicating their agreement to each scenario on a 7-point Likert-type format where 1 means strongly disagree and 7 means strongly agree. Scores are calculated by adding up the points for each item in independent and interdependent scenarios. Higher scores in independence means a more independent self-construal, while higher scores in interdependence stands for a more interdependent self-construal.

Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995) was developed based on attributes of individualism and collectivism proposed by Triandis (1995). The scale divides individualism and collectivism into horizontal and vertical measures of individualism and collectivism. Whilst individualism refers to the

autonomous self and collectivism refers to the perception of the self as an in-group member, horizontal individualism and horizontal collectivism include a sense of equality in status between self and others. In contrast, vertical individualism and vertical collectivism postulates an inequality in status. Responses to the scale are measured on a 9-point Likert-type format (i.e. 1 is strongly disagree and 9 is strongly agree). The responses are added up to calculate the score for each condition. The prominent self-construal style correspond with the aspect of the questionnaire that has the highest score.

Questionnaires that measure self construal were particular important for the first two experimental chapters (Chapters 2 & 3) because they were designed to measure independent and interdependent concepts of the self. The key difference between the two concepts is the idea of the self in relation to others (Gardner, Gabriel & Lee, 1999). Typically, Western cultures are depicted to value independence and perceive the self as autonomous individuals unique from other people, while Eastern cultures are described to value interdependence and emphasises the interconnectedness of the individual to other people (Markus, & Kitayama, 1991). The self bias effect also reflects the concept of the self in relation to others through behavioural measures. Larger differences between self and other (in RTs and d-prime) suggests a more independent view of the self, while smaller differences between self and other (in RTs and d-prime) indicates a more interdependent perspective. Thus, positive correlations between the self bias effect and the self-construal questionnaires would validate cultural differences from both social and experiment psychology perspectives.

7.1.1.2. Other questionnaires

To investigate whether the self bias effect was associated with other personality traits, questionnaires such as the Rosenberg Self Esteem Scale (Rosenberg, 1965), Self Monitoring Scale (Snyder, 1974), Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) were also administered, *see Appendices A.3, A.4 and A.5*.

Self-esteem and self-monitoring are two traits often studied in conjunction with self-construal styles. It is possible that, indirectly, self-esteem and self-monitoring may be linked to the self bias effect through independent and interdependent self-construals. Self-esteem is typically defined as the overall sense of worthiness as a person (Schmitt & Allik, 2005), and the self-reported Rosenberg Self-Esteem Scale (Rosenberg, 1965) is one of the most widely used measure to assess self-esteem. People from individualist cultures were expected to demonstrate a stronger sense of self-esteem due to the emphasis on personal attributes and individual autonomy. Independent individuals attribute one's success more to personal achievements and internal qualities such as talents (Kitayama, Markus, Matsumoto, & Norasakkunkit, 1997; Triandis, 1995), which in turn enhances one's self-esteem. On the other hand, interdependent cultures perceive the individual as merely a constitution of the group. Group harmony is promoted over self-expression, and self-criticism is encouraged (Kitayama et al., 1997; Markus & Kitayama, 1991; Triandis, 1995), which leads to lower self-esteem in comparison to individuals from independent cultures.

The content of the items in the Rosenberg Self-Esteem Scale consisted of 10 statements that describes general feelings about oneself. For example, one's satisfaction or respect for the self, or feelings of self-worth. Participants responded by indicating the level of agreement to each statement (i.e. 1 – strongly disagree, 2 – disagree, 3 – agree, 4 – strongly agree). The score is calculated by adding the points from each statement in accordance to an answer key. The higher the score, the higher the self-esteem.

The Self Monitoring Scale was developed by Snyder (1974). The scale was designed to measure an individual's sensitivity to the situation during social interactions and the conscious effort to adapt and manipulate one's behaviour to the perceived standards of the social environment. According to Ickes and Barnes (1977), people who score high on self-monitoring are more sensitive to environmental cues, better at detecting deception from others, and more intuitive at influencing others' emotions. The scale consists of 25 statements that describes one's reactions to various situations. Participants marked true or false to each statement to indicate whether the description can be applied to the self. The self-monitoring score is calculated by the sum of the number of 'true' responses.

According to Snyder (1979), low self-monitors have an enduring conception of the self which is made up of characteristic behaviours that one draws from in relevant situations. For collectivist individuals this include one's relationship with others present in the situation. As a result, collectivist individuals have less need to adjust one's behaviours according to the perceived standards. Hence, independence should correlate negatively with self-monitoring. This was supported by Gudykunst, Yang and Nishida's (1987) study, where the most individualist sample (from the United States) scored highest in self-monitoring but the more collectivist sample (from Japan and Korea) reported lower levels of self-monitoring. However, findings on self-monitoring and culture have shown different results. For example, Hamid (1994) reported greater self-monitoring in interdependent samples (from China) rather than independent samples (from New Zealand) using a self-monitoring scale developed by Lennox and Wolfe (1984). Thus, it is unclear whether the magnitude of the self-bias effect would be associated with high or low self-monitoring. This thesis used the scale developed by

Snyder (1979) because the concept was first introduced by Snyder. It would be interesting to study the relationship between self bias and self-monitoring.

Additionally, people from independent and interdependent cultures also experience emotions differently. Markus and Kityama (1991) stated that for independent individuals, emotional expression literally means to communicate emotion. However, for interdependent individuals, the expression of emotions may be regarded as a more public act that may or may not reflect one's true inner feelings. People from interdependent cultures are more likely to inhibit the expression of emotions such as anger to avoid the disruption of group harmony, while people from independent cultures are encouraged to express these emotions (Matsumoto, Kudoh, Scherer, & Wallbott, 1988; Matsumoto, 1989; Markus & Kityama, 1991). Thus, the Positive and Negative Affect Schedule was administered in Chapters 2 and 3 to study emotional experiences with the self bias effect.

The Positive and Negative Affect Schedule developed by Watson, Clark, and Tellegen (1988) measures the positive and negative affect or mood of the individual. This questionnaire contains 20 descriptive words, half of which describe positive affect and the other half describe negative affect. Whilst positive affect is characterised by a state of high energy, full concentration and pleasurable engagement, negative affect features sadness, lethargy, subjective distress and other unpleasurable experiences that include a variety of aversive moods such as anger, contempt and disgust (Watson, Clark, & Tellegen, 1988). Though positive and negative affect seems to indicate opposite mood factors, the authors argued that they are in fact distinctive dimensions that are orthogonal to each other. Thus, the score for positive affect and negative affect are scored separately by adding up the points rated for each descriptive word. The

higher the score the more strongly the positive or negative mood experienced by the participant.

7.1.1.3. Reward questionnaires

Sensitivity to Reward Scale (Torrubia et al., 2001) and the Behavioural Activation System (Carver & White, 1994) were administered to measure the strength of one's bias towards high reward, *see Appendices A.8 and A.9*. These questionnaires were administered in Chapters 5 and 6. The intention was to measure whether a strong motivation towards high reward would be linked to the magnitude of the self bias in an attempt to explain the relationship between self and reward processes.

The Sensitivity to Reward Scale is one of two scales from the Sensitivity to Punishment and Sensitivity to Reward Scale (SPSRQ). For the purposes of our studies, only the Sensitivity to Reward Scale was administered. The scale consists of 24 yes-no items that asks about habitual behaviours. The content of the items ranges from money, sensation-seeking, power, sex partners, social events and more. The goal was to describe as many situations as possible from which people can gain reward. The scores were calculated by adding all the "yes" answers together. The higher the score, the more sensitive one is to reward.

The Behavioural Activation System was developed by Carver and White (1994). The scale includes 13 statements and participants selected their agreement to each statement on a Likert-type scale –strongly agree, agree, disagree, and strongly disagree. The content of the statements was designed to reflect qualities that actively seek out, greatly enjoy or respond strongly to reward. According to Carver and White (1994), the statements can be divided into three subscales – fun seeking, drive and reward responsiveness. The fun seeking subscale contains statements that describe the

spontaneous desire to look for and engage in potentially rewarding experiences. The drive subscale consists of statements that refer to the persistent search for desired outcomes. Reward responsiveness is made up of statements that emphasises positive responses in anticipation of reward and during the occurrence of reward. The score is calculated by adding up the scores – strongly agree is 4 points, strongly disagree is 1 point. The stronger the agreement with the statement, the higher the score and the more high reward motivates one's behaviour.

7.1.1.4. Personal distance scale

The Personal Distance Scale (Sui & Humphreys, 2015) was designed to measure the perceived distance between two individuals by the self, *see Appendix A.6*. For the Personal Distance Questionnaire, participants drew two crosses on a continuous line. Each cross represents a person and the distance between the two crosses indicates the perceived distance between the two persons – the smaller the distance between the crosses the closer the relationship between the two persons, in contrast, the larger the distance between the two crosses, the more distant the perceived relationship between the two. Participants were asked to demonstrate the perceived distance between persons such as self and friend, self and stranger, friend and stranger. Each combination of two persons were repeated several times, and the scores were calculated by taking the average of the distance between the two crosses. In Sui and Humphreys' (2015) study, it was found that the distance between self and stranger was positively correlated with the strength of the self-bias effect, which suggested that the Personal Distance Scale is a good indicator of the magnitude of the self bias effect.

7.1.2. Objectives and hypotheses of the current study

The goal of the correlation analyses was to utilise cross-disciplinary methods in psychology to examine the self bias effect. Previous chapters (Chapters 2, 3, 4, 5 and 6) have focused on methods from experimental psychology. In contrast, the current chapter relies on both self biases in behaviour and self-reported questionnaires, which are commonly used in social psychology. The use of the two sub-disciplinary methods allows the study of the self bias effect from different perspectives, which may further current understandings of the self bias effect.

The hypotheses for the questionnaires were as follows. First, the magnitude of the self bias effect from the computer tasks was correlated with measures of independence and interdependence from the Self Construal Scale and the Individualism and Collectivism Scale. It was predicted that 1) higher scores in independent self construal were expected to positively correlate with the magnitude of the self bias effect, whilst higher scores in interdependent self construal were expected to negatively correlate with the magnitude of the self bias effect. 2) D-prime for the self bias effect was also correlated with the two scales to test whether higher sensitivity to the self stimuli was related to higher measures of independent self construal and lower sensitivity to the self stimuli predicted more interdependent self construal.

Second, the behavioural results were correlated with self-reported measures such as self-esteem, self-monitoring, and positive negative affect to test 1) whether the magnitude of the self bias effect would predict measures of self-esteem, self-monitoring, and positive and negative affect. 2) The same questionnaire responses were also analysed with d-prime for the self bias effect to test whether sensitivity to the detection of self-related stimuli would predict self-esteem, self-monitoring and positive negative affect.

Third, to investigate the relationship between reward and the self bias effect, reaction time data from Chapters 5 and 6 were normalised and combined to correlate with two reward questionnaires. The hypotheses for the correlation analyses were 1) A significant correlation between normalised self RTs and normalised reward RTs would demonstrate similarities between the two processes if self-related information was intrinsically high in value. However, if self-related information was not intrinsically high in value, then normalised self RTs and normalised reward RTs would not correlate with each other. 2) A positive correlation between the normalised reward RTs and the Sensitivity to Reward Scale and the Behavioural Activation System would demonstrate that higher reward value motivates processing of high reward stimuli. 3) D-prime for the self bias effect was also correlated with the Sensitivity to Reward Scale and the Behavioural Activation System to test whether high reward value facilitated the detection of reward stimuli (i.e. higher d-prime predicted high reward bias).

Fourth, responses for the Personal Distance Scale was analysed with the self bias effect. The personal distance measure was predicted to correlate with 1) the magnitude of the self bias effect as well as 2) d-prime for the self bias effect.

7.2. Method

7.2.1. Participants

The number of participant responses varied between analyses as the questionnaires administered differed between Chapters, *see Table 25.* Responses from 88 participants (mean age ± standard deviation = 21.18 ± 3.40) were recorded for the Self Construal Scale and the Individualism and Collectivism Scale. This included responses from participants in Chapters 2 and 3. Data from 64 participants (mean age ± standard deviation = 21.67 ± 3.75) were collected for the Rosenberg Self-Esteem Scale,

Self-Monitoring Scale and Positive and Negative Affect Schedule. This included participants from Chapters 2 and 3, except the HK participant in Chapter 2. The HK participants were excluded due to missing data, where the questionnaires were not administered by the local experimenter. The Sensitivity to Reward Scale and the Behavioural Activation System included response from 49 participants (mean age ± standard deviation = 22.94 ± 3.36) from Chapters 5 and 6. Analyses on the Personal Distance Scale consisted of responses from 144 participants (mean age ± standard deviation = 24.6 ± 6.02). This included participants from all studies except the Hong Kong participants in Chapter 2. The personal distance scale was not administered by the local experimenter.

Table 25. Questionnaire data collected corresponding to the Chapters for each correlation analyses.

Studies from Chapters	Number of participant responses	Questionnaire responses collected
Chapters 2, 3	88	Self Construal Scale Individualism and Collectivism Scale
Chapters 2, 3	64	Rosenberg Self-Esteem Scale Self-Monitoring Scale Positive and Negative Affect Schedule
Chapters 5, 6	49	Sensitivity to Reward Scale Behavioural Activation System
Chapters 2, 3, 4, 5, 6	144	Personal Distance Scale

7.2.2. Procedure

The questionnaires were administered either at the beginning (in Chapters 4, 5, and 6) or the end (in Chapters 2 and 3) of each study. In chapters 2, 3, and 4, the questionnaires were administered in paper format, whereas questionnaires were administered online in Chapters 5 and 6.

7.2.3. Experimental design and data analyses

The analyses consisted of correlations which were reported in four sections, *see Table 25 for details*. The first section examined the self bias effect and the self construal questionnaire responses. The second section studied the self bias effect and other questionnaire measures – self-esteem, self-monitoring, and positive and negative affect. The third section correlated self bias with reward bias and questionnaire measures on reward. The last section studied the self bias effect and personal distance. Each section correlated the questionnaire responses with the self bias in both normalised RTs and d-prime. To increase the power of the correlation results, data from multiple studies were combined together. Thus, reaction time results from each study were normalised using (A-B)/(A+B). This method of normalisation is ideal for making comparisons between two conditions such as self and friend or self and stranger. Two types of correlation analyses (i.e. Pearson's rho and Spearman's r) were conducted and reported in the thesis to provide a more comprehensive examination of the data. Pearson's correlation measures linear dependence and may not be able to identify non-linear correlations. On the other hand, Spearman's rho does not require linearity between variables and can also be used to measure ordinal variables (De Siqueira Santos, Takahashi, Nakata, & Fujita, 2013). Bonferroni correction was applied to correct for multiple testing.

7.3. Results

7.3.1. Self bias and self construal questionnaires (Chapters 2 & 3)

This correlation analysis contains data from Chapters 2 and 3. The normalised RT between self and friend as well as between self and stranger were correlated with the Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995) and the Self Construal Scale (Singelis, 1994). No significant results were found. The normalised self and friend RTs were not correlated with either questionnaires and neither were the normalised self and stranger RTs, *see Table 26*.

Table 26. Correlation results between normalised RTs and questionnaire measures from the Self Construal Scale and the Individualism and Collectivism Scale

Variable 1 Normalised RTs	Variable 2 Questionnaire measure	Pearson's *r*	Spearman's rho
Self and friend	Independence	$r = .04$, $p = .71$	$r_s = .07$, $p = .50$
	Interdependence	$r = -.04$, $p = .70$	$r_s = -.03$, $p = .81$
	Individualism (both horizontal and vertical)	$r = .02$, $p = .83$	$r_s = .02$, $p = .88$
	Collectivism (both horizontal and vertical)	$r = .02$, $p = .83$	$r_s = .05$, $p = .63$
	Horizontal Individualism	$r = -.02$, $p = .83$	$r_s = -.01$, $p = .95$
	Vertical Individualism	$r = .05$, $p = .68$	$r_s = .05$, $p = .63$
	Horizontal Collectivism	$r = .01$, $p = .97$	$r_s = .05$, $p = .64$
	Vertical Collectivism	$r = .04$, $p = .73$	$r_s = .06$, $p = .59$
Self and stranger	Independence	$r = .08$, $p = .44$	$r_s = .06$, $p = .56$
	Interdependence	$r = -.10$, $p = .34$	$r_s = -.11$, $p = .31$
	Individualism (both horizontal and vertical)	$r = .12$, $p = .29$	$r_s = .04$, $p = .69$
	Collectivism (both horizontal and vertical)	$r = .12$, $p = .28$	$r_s = .06$, $p = .55$
	Horizontal Individualism	$r = .05$, $p = .68$	$r_s = .03$, $p = .81$
	Vertical Individualism	$r = .14$, $p = .19$	$r_s = .09$, $p = .40$
	Horizontal Collectivism	$r = .11$, $p = .31$	$r_s = .11$, $p = .31$
	Vertical Collectivism	$r = .11$, $p = .30$	$r_s = .05$, $p = .65$

Similarly, the self bias in d-prime was also correlated with the two self construal questionnaires. No significant correlations were found in the self bias in d-prime between self and friend and the questionnaire measures, nor between self and stranger d-prime and the questionnaire measures, *see Table 27.*

Table 27. Correlation results between self bias in d-prime and questionnaire measures from the Self Construal Scale and the Individualism and Collectivism Scale

Variable 1 D-prime	Variable 2 Questionnaire measure	Pearson's *r*	Spearman's rho
Self and friend	Independence	$r = .12$, $p = .25$	$r_s = .07$, $p = .50$
	Interdependence	$r = .11$, $p = .32$	$r_s = .09$, $p = .40$
	Individualism (both horizontal and vertical)	$r = -.00$, $p = .99$	$r_s = .04$, $p = .72$
	Collectivism (both horizontal and vertical)	$r = .09$, $p = .40$	$r_s = .09$, $p = .39$
	Horizontal Individualism	$r = .12$, $p = .26$	$r_s = .08$, $p = .49$
	Vertical Individualism	$r = .12$, $p = .29$	$r_s = .10$, $p = .37$
	Horizontal Collectivism	$r = .06$, $p = .61$	$r_s = .02$, $p = .87$
	Vertical Collectivism	$r = .15$, $p = .18$	$r_s = .15$, $p = .15$
Self and stranger	Independence	$r = -.05$, $p = .62$	$r_s = -.04$, $p = .73$
	Interdependence	$r = -.02$, $p = .85$	$r_s = .06$, $p = .59$
	Individualism (both horizontal and vertical)	$r = .02$, $p = .89$	$r_s = .02$, $p = .88$
	Collectivism (both horizontal and vertical)	$r = .14$, $p = .18$	$r_s = .14$, $p = .18$
	Horizontal Individualism	$r = -.06$, $p = .61$	$r_s = -.01$, $p = .91$
	Vertical Individualism	$r = -.05$, $p = .66$	$r_s = -.06$, $p = .58$
	Horizontal Collectivism	$r = -.03$, $p = .81$	$r_s = .09$, $p = .41$
	Vertical Collectivism	$r = -.01$, $p = .90$	$r_s = .00$, $p = 1.00$

7.3.2. Self bias and other questionnaires (Chapters 2 & 3)

The following analyses contained responses from Chapters 2 and 3. However, data from HK participants (in Chapter 2) were excluded due to missing questionnaire data (i.e. the questionnaire was not administered to Hong Kong participants).

Correlation analyses for the normalised RTs between self and friend and self and stranger were performed with the Rosenberg Self Esteem Scale, Self Monitoring Scale, and the Positive and Negative Affective Schedule. No significant correlations were found between the normalised RTs (both between self and friend, and self and stranger) and the three questionnaires, *see Table 28*.

Table 28. Correlation results between the normalised RTs and measures from Rosenberg's Self Esteem Scale, Self Monitoring Scale, and the Positive and Negative Affect Schedule.

Variable 1 Normalised RTs	Variable 2 Questionnaire measure	Pearson's *r*	Spearman's rho
Self and friend	Self Esteem	r = -.10, p = .45	r_s = -.08, p = .55
	Self Monitoring	r = -.18, p = .15	r_s = -.15, p = .22
	PANAS positive affect	r = .03, p = .80	r_s = .06, p = .66
	PANAS negative affect	r = .03, p = .84	r_s = .04, p = .75
Self and stranger	Self Esteem	r = -.06, p = .62	r_s = -.07, p = .59
	Self Monitoring	r = -.06, p = .63	r_s = -.03, p = .81
	PANAS positive affect	r = .11, p = .39	r_s = .11, p = .39
	PANAS negative affect	r = .10, p = .42	r_s = .07, p = .57

D-prime for the self bias was also correlated with the same questionnaires – Rosenberg's Self Esteem Scale, Self Monitoring Scale, and the Positive and Negative Affect Schedule. No significant findings were found between the self bias in d-prime (both between self and friend, and self and stranger) and the three scales, *see Table 29*.

Table 29. Correlation results between the self bias in d-prime and measures from Rosenberg's Self Esteem Scale, Self Monitoring Scale, and the Positive and Negative Affect Schedule.

Variable 1 D-prime	Variable 2 Questionnaire measure	Pearson's r	Spearman's rho
self and friend	Self Esteem	$r = .08$, $p = .55$	$r_s = .08$, $p = .52$
	Self Monitoring	$r = .04$, $p = .74$	$r_s = .03$, $p = .80$
	PANAS positive affect	$r = .15$, $p = .24$	$r_s = .15$, $p = .22$
	PANAS negative affect	$r = .12$, $p = .36$	$r_s = .08$, $p = .55$
self and stranger	Self Esteem	$r = .08$, $p = .52$	$r_s = .03$, $p = .84$
	Self Monitoring	$r = -.12$, $p = .36$	$r_s = -.10$, $p = .42$
	PANAS positive affect	$r = .09$, $p = .46$	$r_s = .07$, $p = .56$
	PANAS negative affect	$r = .12$, $p = .36$	$r_s = .08$, $p = .51$

7.3.3. Self bias, reward bias and reward questionnaires (Chapters 5 & 6 only)

This analysis focused on data collected from Chapter 5 and 6. The normalised reward RTs from Chapters 5 and 6 were combined together to perform correlation analyses with 1) the normalised social RTs to test whether a stronger reward bias was correlated with a stronger self bias, and 2) the Sensitivity to Reward Scale (Torrubia et al., 2001) and the Behavioural Activation System (Carver & White, 1994). Correlations analyses were also conducted on d-prime.

First, the normalised reward RTs were correlated with the normalised self RTs to test whether stronger reward bias predicted stronger self bias. This revealed a negative correlation between the normalised RTs between 9x and 3x and the normalised RTs between self and stranger in Pearson's r, $r = -.38$, $p < .05$, and in Spearman's rho: $r_s = -.40$, $p < .05$*, see Figure 38 and Table 30*. Further testing confirmed that the significant correlation was not driven by the data point on the far left. This result indicated that the stronger the self bias relative to stranger, the weaker the high reward bias relative to 3x. No other significant results were found between normalised reward RTs and normalised self RTs, *see Table 30.*

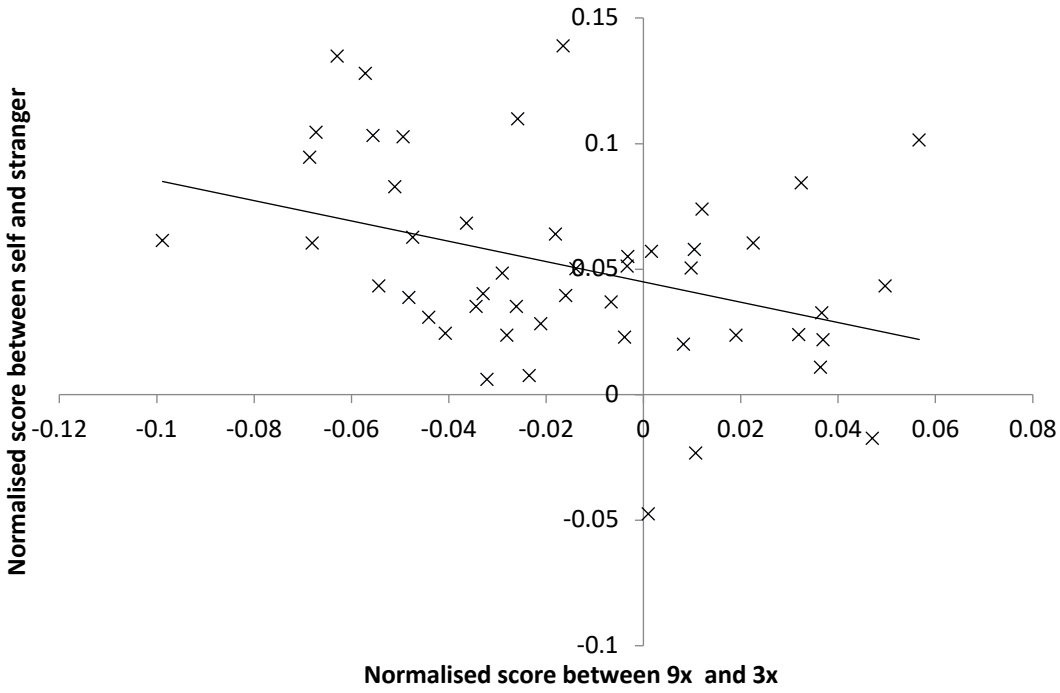


Figure 38. A negative correlation between the normalised 9x and 3x RTs and the normalised self and stranger RTs.

Table 30. Correlation results between normalised self RTs and normalised reward RTs. Significant results are marked with ''.*

Variable 1 Normalised self RTs	Variable 2 Normalised reward RTs	Pearson's *r*	Spearman's rho
self and mother	9x and 7x	$r = .15, p = .29$	$r_s = .25, p = .08$
	9x and 5x	$r = .04, p = .78$	$r_s = .12, p = .43$
	9x and 3x	$r = -.06, p = .67$	$r_s = -.07, p = .63$
	9x and 1x	$r = .18, p = .22$	$r_s = .21, p = .14$
self and friend	9x and 7x	$r = -.00, p = .99$	$r_s = -.06, p = .66$
	9x and 5x	$r = -.02, p = .87$	$r_s = -.10, p = .50$
	9x and 3x	$r = -.16, p = .27$	$r_s = -.22, p = .12$
	9x and 1x	$r = .06, p = .68$	$r_s = -.00, p = .98$
self and acquaintance	9x and 7x	$r = .28, p = .06$	$r_s = .22, p = .13$
	9x and 5x	$r = .09, p = .54$	$r_s = .09, p = .53$
	9x and 3x	$r = -.07, p = .65$	$r_s = -.12, p = .43$
	9x and 1x	$r = .17, p = .26$	$r_s = .16, p = .26$
self and stranger	9x and 7x	$r = -.12, p = .43$	$r_s = -.03, p = .85$
	9x and 5x	$r = -.16, p = .26$	$r_s = -.15, p = .29$
	9x and 3x	$r = -.38, p < .01^*$	$r_s = -.40, p < .01^*$
	9x and 1x	$r = -.20, p = .17$	$r_s = -.19, p = .19$

Second, the normalised reward RTs were correlated with the reward questionnaires. No significant results were found between the normalised reward RTs and the Sensitivity to Reward Scale, nor between the normalised reward RTs and the Behavioural Activation System, *see Table 31*.

Table 31. Correlation results between normalised reward RTs and the questionnaire measures from SPSRQ and BAS.

Variable 1 Normalised reward RTs	Variable 2 Questionnaire measure	Pearson's *r*	Spearman's rho
9x and 7x	SPSRQ	r = -.14, p = .34	r_s = -.10, p = .50
	BAS	r = .09, p = .54	r_s = .08, p = .60
	BAS – drive	r = .02, p = .87	r_s = .07, p = .64
	BAS – reward responsiveness	r = .09, p = .55	r_s = .02, p = .87
	BAS – fun seeking	r = .08, p = .57	r_s = .03, p = .86
9x and 5x	SPSRQ	r = -.15, p = .30	r_s = -.16, p = .27
	BAS	r = .03, p = .85	r_s = .01, p = .93
	BAS – drive	r = .03, p = .82	r_s = .03, p = .85
	BAS – reward responsiveness	r = .03, p = .86	r_s = .03, p = .84
	BAS – fun seeking	r = .00, p = .99	r_s = -.01, p = .95
9x and 3x	SPSRQ	r = -.06, p = .68	r_s = -.03, p = .85
	BAS	r = .06, p = .68	r_s = .06, p = .68
	BAS – drive	r = -.03, p = .85	r_s = .00, p = .99
	BAS – reward responsiveness	r = .11, p = .45	r_s = .12, p = .42
	BAS – fun seeking	r = .04, p = .78	r_s = -.02, p = .90
9x and 1x	SPSRQ	r = -.12, p = .43	r_s = -.13, p = .38
	BAS	r = -.06, p = .69	r_s = .01, p = .94
	BAS – drive	r = -.09, p = .54	r_s = .03, p = .84
	BAS – reward responsiveness	r = .03, p = .82	r_s = .06, p = .68
	BAS – fun seeking	r = -.08, p = .57	r_s = -.08, p = .60

Third, d-prime for the reward bias was also correlated with the reward questionnaires. After Bonferroni correction, no significant results were found between the reward bias in d-prime and the reward questionnaires, *see Table 32.*

Table 32. Correlation results between reward bias in d-prime and the questionnaire measures from SPSRQ and BAS.

Variable 1 D-prime	Variable 2 Questionnaire measure	Pearson's *r*	Spearman's rho
9x and 7x	SPSRQ	r = -.01, p = .92	r_s = -.08, p = .60
	BAS	r = -.07, p = .63	r_s = -.13, p = .38
	BAS – drive	r = -.04, p = .78	r_s = -.05, p = .74
	BAS – reward responsiveness	r = .08, p = .59	r_s = .06, p = .66
	BAS – fun seeking	r = -.19, p = .18	r_s = -.31, p = .03
9x and 5x	SPSRQ	r = .07, p = .63	r_s = .10, p = .50
	BAS	r = .02, p = .88	r_s = .07, p = .66
	BAS – drive	r = -.06, p = .70	r_s = .01, p = .94
	BAS – reward responsiveness	r = .12, p = .43	r_s = .12, p = .41
	BAS – fun seeking	r = -.02, p = .87	r_s = -.04, p = .81
9x and 3x	SPSRQ	r = -.10, p = .50	r_s = -.10, p = .49
	BAS	r = -.20, p = .16	r_s = -.17, p = .25
	BAS – drive	r = -.11, p = .44	r_s = -.05, p = .75
	BAS – reward responsiveness	r = -.06, p = .68	r_s = -.13, p = .36
	BAS – fun seeking	r = -.27, p = .06	r_s = -.22, p = .12
9x and 1x	SPSRQ	r = .11, p = .46	r_s = .11, p = .46
	BAS	r = .15, p = .31	r_s = .16, p = .27
	BAS – drive	r = .11, p = .45	r_s = .05, p = .73
	BAS – reward responsiveness	r = .12, p = .43	r_s = .17, p = .24
	BAS – fun seeking	r = .11, p = .46	r_s = .11, p = .46

7.3.4. Self bias and personal distance scale (Chapters 2 to 6)

The following analyses consisted of data from all studies in this thesis except data from the HK participants in Chapter 2. This was due to a lack of data where the questionnaires were not administered by the Hong Kong experimenter. The personal distance scores used in the correlation analyses were referenced against the distance between self and stranger. For example, the referenced personal distance measure for self and friend is calculated by using the distance between self and friend divided by the distance between self and stranger.

Correlation between the referenced personal distance and the normalised RTs were performed. No correlations were found between the normalised self and friend RTs and the referenced distance between self and friend, nor between the normalised self and stranger RTs and the referenced distance between self and friend, *see Table 33*.

Correlation between the self bias in d-prime and the referenced personal distance scores was also performed. However, no significant effects were found, *see Table 34*.

Table 33. Correlation results between the normalised RTs and the referenced personal distance score between self and friend

Variable 1 Normalised RTs	Variable 2 Personal distance measure	Pearson's *r*	Spearman's rho
Self and friend	Self and friend	r = -.03, p = .74	r_s = .02, p = .86
Self and stranger	Self and friend	r = -.12, p = .16	r_s = -.05, p = .55

Table 34. Correlation results between the self bias in d-prime and the referenced personal distance score between self and friend

Variable 1 D-prime	Variable 2 Personal distance measure	Pearson's *r*	Spearman's rho
Self and friend	Self and friend	r = .02, p = .81	r_s = .03, p = .75
Self and stranger	Self and friend	r = -.10, p = .23	r_s = .00, p = 1.00

7.4. Discussion

The goal of the current chapter was to examine the self bias effect using methods from social psychology. Behavioural data from previous chapters were correlated with self-reported questionnaires to explore whether the magnitude of the self bias effect could predict personal traits such as self construal styles, self-esteem, self-monitoring and more.

7.4.1. Findings and implications

The correlation analyses showed a negative correlation between normalised reward RTs and normalised self RTs. This result may be a direct indication that self and reward processes do not share the exact same underlying process, which supported the behavioural results from Chapters 5 and 6. The results from Chapters 5 and 6 found different patterns of behavioural responses between the self bias effect (relative to mother, friend, acquaintance, stranger) and the high reward bias (relative to 7x, 5x, 3x, 1x) that were consistent with the parallel processing model proposed by Northoff and Hayes (2011). If self-related stimuli carried intrinsic values that motivated faster processes, a positive as opposed to a negative correlation would have been found between normalised reward and self RTs. However, this was not the case in this study. Nevertheless, this particular finding should be interpreted with care due to the lack of other significant results between normalised self and reward RTs.

Unfortunately, no other significant correlations were found between the self bias effect and other trait characteristics (i.e. self-construal, self-esteem, self-monitoring, positive and negative affect, reward sensitivity and personal distance) in this study. It is important to keep in mind that the self is an ambiguous and abstract concept that is difficult to measure (Grace & Cramer, 2003). Many have questioned the reliability of these measures due to inconsistent results. For example, Harb and Smith (2008) criticizes self-construal scales for not providing references to specific contexts in the interdependent measures when interdependent individuals are particularly sensitive to contextual cues. The environment is crucial to providing messages that elicit access to independent or interdependent self construals (Sorensen & Oyserman, 2013). Large scale studies across 30 nations also suggested that the Self Construal Scale is unstable in structure within and across cultures (Georgas et al., 2006; Levine et al., 2003).

Despite the lack of significant findings, the importance of the current chapter was that self-reported questionnaires in social psychology were used to study the self bias effect in perception for the first time. The inclusion of social psychology methods (i.e. questionnaires measures) provides a cross-disciplinary approach to current understandings of the nature of self bias.

7.4.2. Limitations and future research

One limitation was that some questionnaires were administered at the beginning of the testing session whereas others were administered at the end of the testing session. Though most questionnaires were trait measures, it is unclear whether the performance of the computer task before filling out the questionnaires would affect self-reported responses.

Another limitation was the sample size in each of the Chapters in this thesis. Previous studies that consisted of questionnaire responses often required large sample sizes to produce high statistical power. To overcome this and to maximise the power of the correlation analyses in this thesis, responses from two or more chapters were combined together and the behavioural results were also normalised to minimise the differences between groups. However, it is unclear whether combining questionnaire responses from different experiments could impact the results.

Correlation analyses is only one method of finding the link between the self bias effect and other trait characteristics. Future studies should consider other statistical analyses such as mediation analysis, regression, and structural equation models. Future studies could also consider other questionnaires that measure self-related traits. For example, the Five-Factor Model depicts five broad dimensions used to describe personality traits – openness to experience, conscientiousness, extraversion,

agreeableness and neuroticism. These personality traits can be measure with the NEO Personality Inventory (Costa & McCrae, 1992), which may be used to correlate with the self bias.

In conclusion, the current chapter explored the self bias effect through the use of self-reported questionnaires. This social psychology method studied the self bias by examining its relationship with other concepts of the self such as traits characteristics. These findings were able to provide a new perspective as well as a more comprehensive understanding of the self bias effect in addition to behavioural measures.

Chapter 8

General discussion

The self bias effect, or the prioritisation of self-related processing, has been observed in many areas. For example, self-name can be recognised against a noisy background even when other information is not noticed (Cherry, 1953; Moray, 1959). Judgments made on the orientation of self faces are faster and more accurate compared with faces of others (e.g. Ma & Han 2010; Tong & Nakayama, 1999). Information encoded in relation to the self results in better memory recognition and recall (e.g. Cunningham, Turk, Macdonal, & Macrae, 2008; Hanami, Serbun, & Gutchess, 2011; Symon & Johnson, 1997). Neuroimaging studies also found greater activation in the medial prefrontal cortex and the posterior cingulate in response to self-related processing but not to others (e.g. Kelley et al., 2002; Northoff et al., 2006). The self bias is a very robust effect consistently observed throughout different areas of cognition.

However, current understanding of the self bias effect is still limited. For example, it is unclear whether the magnitude of the self bias can be modulated, and what the underlying mechanisms are for self bias. In order to address these questions, the general aim of this thesis is to gain a better understanding by focusing on these questions: 1) what factors can modulate the self bias effect, 2) what are the potential mechanisms that underlie the self bias effect and 3) whether the self bias effect could be linked to other concepts of the self such as trait characteristics (e.g. self-construal, self-esteem).

To answer these questions, the first half of the thesis (Chapters 2-4) investigated factors that could modulate the self bias effect. Chapter 2 studied the effect of cultural background on self bias by comparing the behavioural difference between participants from Hong Kong and the United Kingdom. In Chapter 3, cultural priming was used to examine the impact of social context on the self bias effect. Chapter 4 looked at the

effect of major life developments, specifically becoming a mother, on the self bias effect. The second half of the thesis (Chapters 5 and 6) explored the potential mechanisms that underlie the self bias effect. To study the relationship between self processing and reward processing, Chapter 5 compared the behavioural responses to self-related stimuli and reward, and Chapter 6 examined the electrophysiological responses to self-related stimuli and reward. Moreover, Chapter 7 used self-reported questionnaire measures to study the relationship between the self bias effect and other trait characteristics such as self construal, self-esteem, positive and negative affect. The following sections will discuss findings from the preceding chapters to draw some final conclusions.

8.1. Social experiences modulate the self bias effect

Both Chapters 2 and 3 studied the effects of culture on the self bias effect. The concept of the self is formed with heavy influence from one's cultural background (Markus & Kitayama, 2010). People from western societies such as North America and west European countries are often perceived as showing independent self-construal, whereas people from East Asian countries such as China, Korea, and Japan are typically viewed as showing interdependent self-construal. In Chapter 2, the self bias effect was compared between independent and interdependent cultures. Both participants from Hong Kong and the United Kingdom completed the perceptual matching task where each participant learned to associate a shape with a label (e.g. self is square, friend is circle and stranger is triangle), then made judgements on whether the shape and label displayed on screen is the correct association or not. The results showed a larger self-bias relative to stranger (i.e. stranger RTs – self RTs) in the UK participants compared to the HK participants. The weaker self bias (relative to stranger) suggested that the HK

participants were more interdependent than their UK counterparts and perceived the self as more connected to others than as an autonomous entity. This difference in the self bias effect between HK and the UK participants demonstrated that one's cultural experience can have an impact in the way information is processed about the self in relation to others. The effects were consistent with findings from previous studies (e.g. Chua, Boland & Nisbett, 2005; Masuda & Nisbett, 2001; Wagar & Cohen, 2003; Zhu, Zhang, Fan, & Han, 2007).

Previous research on cross-culture comparisons often consisted of stimuli that contain previously highly familiar stimuli (e.g. images of self face or familiar face) or examined cognitive processes such as memory and high level decision-making (Cunningham et al., 2008; Turk, Cunningham & Macrae, 2008). Chapter 2 differs from previous research in that it examined the self bias effect in low-level processing (i.e. perceptual matching task) across cultures while using neutral stimuli (i.e. geometric shapes) to control the effect of familiarity. These results play an important role as they demonstrate the effects of cultural background on low-level self-related processing under a controlled method. The between-subjects design of this study identified cultural backgrounds as a modulating factor for the self bias effect. However, the self is not a fixed concept but a spontaneous and dynamic entity influenced by context (Wagar & Cohen, 2003).

Hence, to investigate the effects of social context on the self bias effect, Chapter 3 used cultural priming to test whether situational primes could shift one's frame of mind from one self-construal style to another (e.g. independent to interdependent) and modulate self bias as a result. In the first experiment, an implicit priming method was used to prime the participants with neutral, independent or interdependent frames of mind before completing a perceptual matching task. The second experiment employed

an explicit priming method to elicit neutral, independent or interdependent thoughts. Chapter 3 relied on priming methods that have been tested in past research (e.g. Chiao et al., 2010; Sui et al., 2012). An important factor that sets this experiment apart from past research was the use of two priming methods. Typically, cultural priming studies only use one priming method and do not differentiate between implicit and explicit priming. The use of both implicit and explicit priming in Chapter 3 allowed parallel comparisons of the two methods. In both experiments, it was found that interdependent priming successfully reduced the self bias relative to friend in participants with low bias. However, the same effect was not observed after independent priming. Nor was independent or interdependent priming successful on participants with high bias. These findings indicated that social context can modulate self bias in people who are more sensitive to their surroundings. The pattern of the results in this Chapter was consistent with the findings from the study by Gardner and colleagues (1991). However, the split of participants into low and high bias groups, in this study, recognises that individual differences exist among participants.

Apart from culture, other experiences may also impact the self bias effect. Chapter 4 shifted the focus from cultural experiences to life experiences to examine whether major life developments such as motherhood can impact the self bias effect. The transition into motherhood requires one to change mentally and behaviourally (Barba & Selder, 1995) to ensure that the infant is properly cared for. In particular, it is crucial for mothers to develop maternal sensitivity (Young et al., 2016), which refers to the mother's awareness and response to infant cues (Ainsworth, Blehar, Waters, & Wall, 1978). To study the effects of maternal sensitivity on the self bias effect, women who recently gave birth were recruited to complete the perceptual matching task with infant as one of the stimuli. Whilst a robust self-bias effect was still found in relation to

friend and stranger, responses to infant stimuli was even faster and more accurate than those of the self stimuli. This is the first time that a loss of the self bias effect was observed. The transition into motherhood appeared to have resulted in the development of an infant bias, which supported the idea that life experiences can also be a factor that modulate the self bias effect. Moreover, a negative correlation was found between the self bias relative to stranger and the quality of attachment subscale in the Maternal Postnatal Attachment Scale, which suggested that mothers who shared better attachment with the infant exhibited weaker bias against strangers. This may possibly be a side effect of increased oxytocin levels after pregnancy, as oxytocin help form close relationships with others (Gimpl & Fahrenholz, 2001) and can make strangers seem more trustworthy (Theodoridou, Rowe, Penton-Voak, & Rogers, 2009).

The majority of previous research that study the relationship between mother and infant revolve around mother-infant interactions and its effect on infant development (e.g. Feldman et al., 2007; Strathearn et al., 2009). Hardly any previous research has studied the cognitive changes from the mother's perspective, especially in information processing. This makes the findings from this study particularly important as it contributes to current understanding of the mother-infant relationship from a novel perspective. Moreover, the design of this study could potentially be used as a behavioural measure for maternal sensitivity, especially when previous measures have mostly relied on observations and self-reported questionnaires.

Overall, these chapters have identified three factors that modulate the self bias effect – cultural background, sensitivity to social context, and major life developments. However, it is unclear what drives the robustness of the self bias effect. Thus, exploratory studies were conducted to investigate the underlying mechanisms of the self bias effect.

8.2. Exploration of the relationship between self bias and reward processes

Both self-related stimuli and high reward have been observed to elicit faster responses and higher accuracy in task performance (e.g. Sui, He & Humphreys, 2012). It has been speculated that self-related information and reward are processed with similar mechanisms. This is supported by evidence that both self and reward processes involve activity in shared brain regions such as the ventral medial prefrontal cortex (e.g. De Greck et al., 2008). However, other studies also provide evidence that support parallel processing of self and reward processes (Yankouskaya et al., 2017). Thus, the underlying mechanisms for the self bias effect is still unclear. Chapter 5 explored the relationship between self and reward processes through the comparison of the behavioural results to find out whether the self and reward biases showed similar patterns. However, behavioural responses alone cannot explain the specific cognitive processes involved in producing the results. Hence, building on the foundations of Chapter 5, Chapter 6 took advantage of the temporal resolution of the ERP technique to further investigate the relationship between the self and reward processes by recording the electrophysiological responses to each shape stimulus associated with different labels or reward values. In both chapters, participants learned to associate different shapes with personal labels as well as monetary reward in two separate testing sessions. Given that the same perceptual matching task was used to test reward and self processes, the pattern of the behavioural results was used as an index to determine whether self-related information was processed similarly to high reward.

Across both chapters, the social and reward tasks demonstrated different patterns in the behavioural results, which suggested partially distinct self and reward mechanisms. The social tasks revealed a gradual increase of RTs from self to stranger,

while the reward tasks showed an inverted U-shape in the RTs distribution (i.e. fastest RTs in the lowest and highest reward 1x and 9x, but slowest RTs in 5x). Although both the self and high reward (9x) associations elicited the fastest RTs, the pattern of the rest of the reward (7x, 5x, 3x, 1x) and social associations (mother, friend, acquaintance, stranger) were different, which indicated at least partially separate pathways for reward and self-related processes.

Consistent with the behavioural results, the ERP results also showed different patterns between the reward and social stimuli, especially in the early visual attention N1 component. Inconsistent with previous findings, which demonstrated increased N1 amplitudes as a result of increased significance of the stimuli (Liu, He, Rotshtein, & Sui, 2016; Plihal et al., 2001), the reduced N1 amplitude in response to the self shape in this study may be explained by the automatic attention capture of self-related stimuli (Alexopoulos, Muller, Ric, & Marendaz, 2012; Bargh, 1982). In other words, self-related stimuli may receive better processing but requires less attention in comparison to other stimuli. High reward 9x, however, elicited increased N1 amplitudes as predicted based on previous studies (Hickey, Chelazzi, & Theeuwes, 2010; van den Berg, et al., 2014). Moreover, the lowest reward (1x) also elicited increased P300 along with the self and high reward (9x) stimuli. This was unexpected as only the self and high reward 9x was expected to show increased amplitudes based on past research (e.g. Tacikowski & Nowicka, 2010; Yeung & Sanfey, 2006). It is possible that participants found the five association task too demanding on memory and as a result used the two extreme values (1x and 9x), as anchors, to facilitate memorisation of the other associations. Thus, 1x received more attentional resources (as demonstrated by increased P300 amplitudes) than anticipated. Similar to the behavioural results, the other reward and social stimuli elicited different patterns of N1 and P300 amplitudes,

indicating partially distinct processes. These results were in line with the parallel processing model proposed by Northoff and Hayes (2011) and seemed to suggest that the relationship between self and reward processing is more complex than just self-related information carrying higher intrinsic value.

Although the underlying mechanism of the self bias effect is still unknown, the results from Chapters 5 and 6 suggested at least partially distinct processes between self-related processing and the reward system.

8.3. The relationship between self bias and trait characteristics

In addition to the behavioural and electrophysiological measures, self-reported questionnaire measures were also administered throughout the studies, which allowed for a cross-disciplinary approach in psychology to the investigation of the self bias effect. The self bias effect was correlated with questionnaires that measured various traits to examine if the magnitude of the self bias could predict trait characteristics. For example, self construal was measured using two widely accepted scales, Self Construal Scale (Singelis, 1994), and the Individualism and Collectivism Scale (Singelis, Triandis, Bhawuk & Gelfand, 1995). The Rosenberg Self-Esteem Scale was used to measure the one's overall sense of worthiness (Rosenberg, 1965). The Sensitivity to Reward Scale (Torrubia et al., 2001), and Behavioural Activation System (Carver & White, 1994) measured one's bias towards high reward. Although a negative correlation was found between normalised reward RTs (between 9x and 3x) and normalised self RTs (between self and stranger), this single correlation alone was not enough evidence to explain the relationship between self and reward processes.

Though the intention was for social psychology methods to provide a more comprehensive view on the self in conjunction with methods from experimental

psychology, the findings from this thesis were unable to link the self bias effect to other concepts of the self such as trait characteristics. However, these results should inspire future research to find links between the self bias effect and other traits characteristics.

8.4. Significance of the current thesis

Through multiples studies and the use of approaches including behavioural and electrophysiological measures, this thesis aimed to gain a better understanding of the self bias effect by answering the following questions: 1) what factors can modulate the self bias effect, 2) what are the potential mechanisms that underlie the self bias effect and 3) whether the self bias effect could predict other concepts of the self such as traits (e.g. self-construal, self-esteem)? Findings from this thesis have 1) identified three factors that have modulating effects on self bias – cultural background, sensitivity to social context and major life developments, 2) provided evidence for the idea that self-related information may not share the exact same mechanism as the reward system and 3) demonstrated that the self bias effect could not be linked to other trait characteristics, at least not in this particular thesis, though the results may be due to limited sample size in each analyses.

The factors that have been identified to modulate the self bias effect provide evidence that the self is not a permanent and stable concept, but a temporary and malleable concept that can be accessed dynamically (Colzato, de Bruijn, & Hommel, 2012; Markus & Kunda, 1986; Markus & Wurf 1987; Oyserman, Sorensen, Reber, & Chen, 2009). The self is, in fact, a combination of some key characteristic of the long-term self and the immediate situation (McGuire, McGuire, Chile, & Fujioka, 1978; McGuire & Padawer-Singer, 1976). In other words, the self has the ability to adapt to any situation by adjusting one's behaviours according to the social context. Chapters 2,

3 and 4 confirmed this as the self bias effect adjusted to the situational changes, whether by manipulation (i.e. cultural priming) or by the choice of the participants (i.e. giving birth and becoming a mother). In any case, the results of these studies demonstrated the dynamics of the self as well as the modulation of the self bias effect.

Additionally, the perceptual matching paradigm used throughout the thesis has proven to be a versatile tool that tightly controls for confounding variables such as visual familiarity. This in turn increases the reliability and validity of the results. For example, previous cross-culture studies often used stimuli such as faces and texts (e.g. Chiao et al., 2009; Keenan et al., 1999; Sui, Liu, & Han, 2009; Zhang & Mittel, 2007). However, visual familiarity of faces and translational problems can potentially influence the results without notice. Similarly, previous studies that compared reward and self processes often consisted of different testing paradigms (e.g. Izuma, Saito, & Sadato, 2008). The use of geometric shapes as stimuli removes these confounds due to its universal recognition. Moreover, the geometric shapes remove any pre-existing conditions or predispositions that may affect the results.

8.5. Limitations and future research

There are many interesting questions that require further study. For example, whether the magnitude of the self bias changes throughout the life span. It is yet unclear whether the magnitude of the self bias varies between different age groups. Does the bias become stronger as people age? Or is it stronger during childhood, becomes weaker in adulthood and becomes stronger again in senior years? The study of the self bias effect is still relatively new and there are many questions that have not been answered regarding how self-related information is processed. Further research is needed to better understand the attributes of the self bias effect.

Another question to consider is the relationship between oxytocin and the self bias effect. Oxytocin is a neuropeptide that is the foundation for social bonding such as forming close relationship (Gimpl & Fahrenholz, 2001). This not only refer to mother-infant relationship but also friendship, in-group bonding (Sheng, Liu, Zhou, Zhou, Han, 2013) and romantic attachment (Marazziti et al., 2006). Research also suggest that oxytocin increases trust (e.g. Cardoso, Ellenbogen, Serravalle & Linnen, 2013; Lane et al., 2013; Theodoridou, Rowe, Penton-Voak & Rogers, 2009). It would be interesting to see whether oxytocin could modulate the self bias effect due to its role in forming close relationships.

Findings from the study on the self bias effect in mothers (Chapter 4) also provided foundation for further research. This study is only beginning to uncover the cognitive changes in self-related processing as a result of parenthood. Future studies may investigate changes in the self bias effect in fathers or adoptive parents. Moreover, it would be intriguing to find out whether the infant-bias diminishes as the infant grows older.

In conclusion, the main goal of this thesis was to investigate the modulation and the underlying mechanisms of the self bias effect. First, three factors that modulate the self bias effect was identified – cultural background, sensitivity to social context and major life developments. Second, exploration of the self and reward processes have shown at least partial distinction between the two mechanisms. Finally, the self bias effect was not be linked to other trait characteristics, at least not in this particular thesis. With these findings, this thesis hope to provide information that could improve current understanding of the self bias effect.

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Appendix A.
Questionnaires

A.1 Self-Construal Scale

This is a questionnaire that measures a variety of feelings and behaviors in various situations. Listed below are a number of statements. Read each one as if it referred to you. Then, indicate your degree of agreement or disagreement with each statement (1=strongly disagree; 7=strongly agree). Please respond to every statement. Thank you.

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

A.2 Individualism and Collectivism Scale

The questionnaire is anonymous, and there are no right or wrong answers. We want to know if you strongly agree or disagree with some statements. The number ranges from strongly disagree (1) to strongly agree (9). If you strongly agree, enter a 9 in the blank space; if you strongly disagree, enter a 1 in that space; if you are unsure, enter a 5 next to the statement. If you think the question does not apply to you, use a 5 and draw a circle around the 5. In short, use this key:

Strongly Disagree 1 2 3 4 5 6 7 8 9 Strongly Agree

1. My happiness depends very much on the happiness of those around me _____
2. I would do what would please my family, even if I detested that activity _____
3. I usually sacrifice my self-interest for the benefit of my group _____
4. I enjoy working in situations involving competition with others _____
5. The well-being of my co-workers is important to me _____
6. I enjoy being unique and different from others in many ways _____
7. Children should feel honoured if their parents receive a distinguished award _
8. I often do "my own thing"_____
9. Competition is the law of nature _____
10. If a co-worker gets a prize, I would feel proud _____
11. I am a unique individual _____
12. I would sacrifice an activity that I enjoy very much if my family did not approve of it _____
13. Without competition it is not possible to have a good society _____
14. I feel good when I cooperate with others _____

We now have a set of scenarios. Each scenario is followed by four options. Please place yourself mentally in that situation and rank these options by placing a 1 next to the option you consider the best or the most "right" or "appropriate." Place a 2 next to the next best option; and a 4 next to the least good option.

15. You and your friends decided spontaneously to go out to dinner at a restaurant. What do you think is the best way to handle the bill?

Please rank the four options

A. Split it equally, without regard to who ordered what _____

B. Each person decides how much to contribute to the total, and if that does not cover the bill, each person is assessed inversely proportionally to what he/she has contributed _

C. The group leader pays the bill or decides how to split it _____

D. Compute each person's charge, according to what that person ordered _____

16. You are buying a piece of art for your office. Which one factor is most important in deciding whether to buy it?

A. It is a good investment _____

B. Your co-workers will like it _____

C. You just like it _____

D. Your supervisor will approve of it _____

17. Suppose you had to use one word to describe yourself. Which one would you use?

A. unique _____

B. competitive _____

C. cooperative _____

D. dutiful _____

18. Happiness is attained by

A. gaining a lot of status in the community _____

B. liking with a lot of friendly people _____

C. keeping one's privacy _____

D. winning in competitions _____

19. You are planning to take a major trip that is likely to inconvenience a lot of people at your place of work, during your absence. With whom will you discuss it before deciding whether or not to take it?

A. No one _____

B. Your parents _____

C. Your spouse or close friend _____

D. Experts about the place I plan to travel to so I can decide if I want to go _____

20. Which one of these four books appears to you to be the most interesting?

A. How to make friends _____

B. How to succeed in business _____

C. How to enjoy yourself inexpensively _____

D. How to make sure you are meeting your obligations _____

21. Which is the most important factor in an employee's promotion, assuming that all other factors such as tenure and performance are equal? Employee is or has

A. loyal to the corporation _____

B. obedience to the instructions from management _____

C. able to think for him/herself _____

D. has contributed to the corporation much in the past _____

22. When you buy clothing for a major social event you would be most satisfied if

A. you like it _____

B. your parents like it _____

C. your friends like it _____

D. it is so elegant that it will dazzle everyone _____

23. In your opinion, in an ideal society national budgets will be determined so that

A. all people have adequate incomes to meet basic needs _____

B. some people will be rewarded for making brilliant contributions _____

C. there will be maximal stability, law, and order _____

D. people can feel unique and self-actualized _____

24. When people ask me about myself, I will talk about

A. my ancestors and their traditions _____

B. my friends, and what we like to do _____

C. my accomplishments _____

D. what makes me unique _____

25. Suppose your fiancé and your parents do not get along very well. What would you do?

A. Nothing _____

B. Tell my fiancé that I need my parents' financial support and he or she should learn to handle the politics _____

C. Tell my fiancé that he or she should make a greater effort to "fit in with the family" _____

D. Remind my fiancé that my parents and family are very important to me and he or she should submit to their wishes _____

26. Teams of five people entered a science project contest. Your team won first place and a prize of £100. You and another person did 95% of the work on this project. How should the money be distributed?

A. Split it equally, without regard to who did what _____

B. The other person and I get 95% of the money and the rest goes to the group _____

C. The group leader decides how to split the money _____

D. Divide the money the way that gives me the most satisfaction _____

27. Imagine you are selecting a band for a fund-raising event given by your organisation. Which are the most important factors in making your decision?

A. I really like the band _____

B. My friends approve of this band _____

C. The administration of my organisation approves of the band _____

D. The band will draw a large crowd _____

28. You need to choose one more class for next semester. Which one will you select?

A. The one that will help me get ahead of everyone else _____

B. The one my parents said to take _____

C. The one my friends plan to take _____

D. The one that seems most interesting to me _____

29. You are at a pizza restaurant with a group of friends. How should you decide what kind of pizza to order?

A. The leader of the group orders for everyone _____

B. I order what I like _____

C. We select the pizza that most people prefer _____

D. We order the most extravagant pizza available _____

30. Which candidate will you vote for in the election for president of the student government?

A. The one your friends are voting for _____

B. The one I like best _____

C. The one who will reward me personally _____

D. The one who is a member of an organisation important to me. The status of the organisation will improve if that candidate is elected _____

A.3 Self-Esteem Scale

Below is a list of statements dealing with your general feelings about yourself. If you strongly agree, circle SA. If you agree with the statement, circle A. If you disagree, circle D. If you strongly disagree, circle SD.

	Strongly disagree	**Disagree**	**Agree**	**Strongly agree**
1. On the whole, I am satisfied with myself.	**1**	**2**	**3**	**4**
2. At times, I think I am no good at all.	**1**	**2**	**3**	**4**
3. I feel that I have a number of good qualities.	**1**	**2**	**3**	**4**
4. I am able to do things as well as most other people.	**1**	**2**	**3**	**4**
5. I feel I do not have much to be proud of.	**1**	**2**	**3**	**4**
6. I certainly feel useless at times.	**1**	**2**	**3**	**4**
7. I feel that I'm a person of worth, at least on an equal plane with others.	**1**	**2**	**3**	**4**
8. I wish I could have more respect for myself.	**1**	**2**	**3**	**4**
9. All in all, I am inclined to feel that I am a failure.	**1**	**2**	**3**	**4**
10. I take a positive attitude toward myself.	**1**	**2**	**3**	**4**

A.4 Self-Monitoring Scale

The statements below concern your personal reactions to a number of situations. No two statements are exactly alike, so consider each statement carefully before answering. If a statement is true or mostly true as applied to you, mark T as your answer. If a statement is false or not usually true as applied to you, mark F as your answer. It is important that you answer as frankly and as honestly as you can. Record your responses in the spaces provided on the left.

___1. I find it hard to imitate the behavior of other people.
___2. My behavior is usually an expression of my true inner feelings attitudes, and beliefs.
___3. At parties and social gatherings I do not attempt to do or say things that others will like.
___4. I can only argue for ideas I already believe.
___5. I can make impromptus peeches even on topics about which I have almost no information.
___6. I guess I put on a show to impress or entertain people.
___7. When I am uncertain how to act in a social situation, I look to the behavior of others for cues.
___8. I would probably make a good actor.
___9. I rarely need the advice of my friends to choose movies, books, or music.
___10. I sometimes appear to others to be experiencing deeper emotions than I actually am.
___11. I laugh more when I watch a comedy with others than when alone.
___12. In a group of people I am rarely the center of attention.
___13. In different situations and with different people, I often act like very different persons.
___14. I am not particularly good at making other people like me.
___15. Even if I am not enjoying myself, I often pretend to be having a good time.
___16. l'm not always the person I appear to be.
___17. I would not change my opinions (or the way I do things) in order to please someone else or win their favor.
___18. I have considered being an entertainer.
___19. In order to get along and be liked, I tend to be what people expect me to be rather than anything else.
___20. I have never been good at games like charades or improvisational acting.
___21. I have trouble changing my behavior to suit different people and different situations.
___22. At a party, I let others keep the jokes and stories going.
___23. I feel a bit awkward in company and do not show up quite so well as I should.
___24. I can look anyone in the eye and tell a lie with a straight face (if for a right end).
___25. I may deceive people by being friendly when I really dislike them.

A.5 Positive and Negative Affect Schedule

Please indicate the extent to which you have felt this way today based on a 5-point rating scale. (1 = very slightly/not at all to 5 = extremely)

	1--------2--------3--------4--------5
	(not at all) (extremely)
Determined	
Active	
Afraid	
Strong	
Alert	
Ashamed	
Attentive	
Distressed	
Enthusiastic	
Excited	
Guilty	
Hostile	
Inspired	
Upset	
Interested	
Irritable	
Jittery	
Nervous	
Proud	
Scared	

A.6 Personal Distance Scale

Please mark two points on the following lines to indicate where two people fall in relative to one another. Just put '×' to represent each person. The first mark refers to the first person and the second mark represents the second person.

Please circle one of the following names as a stranger. Potential names:
John Peter Andrew Frank Bob Phil Matt Brian George Alan Simon David
Susan Kate Sally Rachel Sarah Dianna Christine Elizabeth Margaret Polly Mary
For example, person 1 and person 2 _____×_____×_____

1. Stranger and self _____

2. Self and friend _____

3. Friend and stranger _____

4. Friend and self _____

5. Stranger and friend _____

6. Self and stranger _____

7. Stranger and self _____

8. Friend and stranger _____

9. Friend and self _____

10. Self and friend _____

11. Stranger and friend _____

12. Self and stranger _____

13. Self and friend _____

14. Friend and self _____

15. Stranger and friend _____

16. Stranger and self _____

17. Friend and stranger _____

18. Self and stranger _____

19. Stranger and friend _____

20. Self and stranger _____

21. Self and friend _____

22. Stranger and self _____

23. Friend and stranger _____

24. Friend and self _____

25. Stranger and self _____

26. Self and friend _____

27. Friend and stranger _____

28. Friend and self _____

29. Stranger and friend _____

30. Self and stranger _____

A.7 Maternal Postnatal Attachment Scale

MATERNAL POSTNATAL ATTACHMENT SCALE

PM1 When I am caring for the baby, I get feelings of annoyance or irritation:

- ☐ Very frequently
- ☐ Frequently
- ☐ Occasionally
- ☐ Very rarely
- ☐ Never

PM2 When I am caring for the baby I get feelings that the child is deliberately being difficult or trying to upset me:

- ☐ Very frequently
- ☐ Frequently
- ☐ Occasionally
- ☐ Very rarely
- ☐ Never

PM3 Over the last two weeks I would describe my feelings for the baby as:

- ☐ Dislike
- ☐ No strong feelings towards the baby
- ☐ Slight affection
- ☐ Moderate affection
- ☐ Intense affection

PM4 Regarding my overall level of interaction with the baby I:

- ☐ Feel very guilty that I am not more involved
- ☐ Feel moderately guilty that I am not more involved
- ☐ Feel slightly guilty that I am not more involved
- ☐ I don't have any guilty feelings regarding this

PM5 When I interact with the baby I feel:

- ☐ Very incompetent and lacking in confidence
- ☐ Moderately incompetent and lacking in confidence
- ☐ Moderately competent and confident
- ☐ Very competent and confident

PM6 When I am with the baby I feel tense and anxious:

- ☐ Very frequently
- ☐ Frequently
- ☐ Occasionally
- ☐ Almost never

PM7 When I am with the baby and other people are present, I feel proud of the baby:

- ☐ Very frequently
- ☐ Frequently
- ☐ Occasionally
- ☐ Almost never

PM8 I try to involve myself as much as I possibly can PLAYING with the baby:

- ☐ This is true
- ☐ This is untrue

PM9 When I have to leave the baby:

- ☐ I usually feel rather sad (or it's difficult to leave)
- ☐ I often feel rather sad (or it's difficult to leave)
- ☐ I have mixed feelings of both sadness and relief
- ☐ I often feel rather relieved (and it's easy to leave)
- ☐ I usually feel rather relieved (and it's easy to leave)

PM10 When I am with the baby:

- ☐ I always get a lot of enjoyment/satisfaction
- ☐ I frequently get a lot of enjoyment/satisfaction
- ☐ I occasionally get a lot of enjoyment/satisfaction
- ☐ I very rarely get a lot of enjoyment/satisfaction

PM11 When I am not with the baby, I find myself thinking about the baby:

- ☐ Almost all the time
- ☐ Very frequently
- ☐ Frequently
- ☐ Occasionally
- ☐ Not at all

PM12 When I am with the baby:

- ☐ I usually try to prolong the time I spend with him/her
- ☐ I usually try to shorten the time I spend with him/her

PM13 When I have been away from the baby for a while and I am about to be with him/her again, I usually feel:

- ☐ Intense pleasure at the idea
- ☐ Moderate pleasure at the idea
- ☐ Mild pleasure at the idea
- ☐ No feelings at all about the idea
- ☐ Negative feelings about the idea

PM14 I now think of the baby as:

- ☐ Very much my own baby
- ☐ A bit like my own baby
- ☐ Not yet really my own baby

PM15 Regarding the things that we have had to give up because of the baby:

- ☐ I find that I resent it quite a lot
- ☐ I find that I resent it a moderate amount
- ☐ I find that I resent it a bit
- ☐ I don't resent it at all

PM16 Over the past three months, I have felt that I do not have enough time for myself or to pursue my own interests:

- ☐ Almost all the time
- ☐ Very frequently
- ☐ Occasionally
- ☐ Not at all

PM17 Taking care of this baby is a heavy burden of responsibility. I believe this is:

- ☐ Very much so
- ☐ Somewhat so
- ☐ Slightly so
- ☐ Not at all

PM18 I trust my own judgement in deciding what the baby needs:

- ☐ Almost never
- ☐ Occasionally
- ☐ Most of the time
- ☐ Almost all the time

PM19 Usually when I am with the baby:

- ☐ I am very impatient
- ☐ I am a bit impatient
- ☐ I am moderately patient
- ☐ I am extremely patient

A.8 Sensitivity to Reward Scale

Please respond to the following questions by circling yes *or* no.

1. Does the good prospect of obtaining money motivate you strongly to do some things? Yes No
2. Are you frequently encouraged to act by the possibility of being valued in your work, in your studies, with your friends or with your family? Yes No
3. Do you often meet people that you find physically attractive? Yes No
4. Do you like to take some drugs because of the pleasure you get from them? Yes No
5. Do you often do things to be praised? Yes No
6. Do you like being the centre of attention at a party or a social meeting? Yes No
7. Do you spend a lot of your time on obtaining a good image? Yes No
8. Do you need people to show their affection for you all the time? Yes No
9. When you are in a group, do you try to make your opinions the most intelligent or the funniest? Yes No
10. Do you often take the opportunity to pick up people you find attractive? Yes No
11. As a child, did you do a lot of things to get people's approval? Yes No
12. Does the possibility of social advancement, move you to action, even if this involves not playing fair? Yes No
13. Do you generally give preference to those activities that imply an immediate gain? Yes No
14. Do you often have trouble resisting the temptation of doing forbidden things? Yes No
15. Do you like to compete and do everything you can to win? Yes No
16. Is it easy for you to associate tastes and smells to very pleasant events? Yes No
17. Are there a large number of objects or sensations that remind you of pleasant events? Yes No
18. When you start to play with a slot machine, is it often difficult for you to stop? Yes No
19. Do you sometimes do things for quick gains? Yes No
20. Does your attention easily stray from your work in the presence of an attractive stranger? Yes No
21. Are you interested in money to the point of being able to do risky jobs? Yes No
22. Do you like to put competitive ingredients in all your activities? Yes No
23. Would you like to a socially powerful person? Yes No
24. Do you like displaying your physical abilities even thought this may involve danger? Yes No

A.9 Behavioural Activation System

Please indicate your agreement to the following statement using the scale below:

1 – Strong Disagreement 2 – Disagreement 3 – Agreement 4 – Strong Agreement

( ) 1. When I get something I want, I feel excited and energized.
( ) 2. When I'm doing well at something, I love to keep at it.
( ) 3. When good things happen to me, it affects me strongly.
( ) 4. It would excite me to win a contest.
( ) 5. When I see an opportunity for something I like, I get excited right away
( ) 6. When I want something, I usually go all-out to get it.
( ) 7. I go out of my way to get things I want.
( ) 8. If I see a chance to get something I want, I move on it right away.
( ) 9. When I go after something I use a "no hold barred" approach.
( ) 10. I will often do things for no other reason than that they might be fun.
( ) 11. I crave excitement and new sensations.
( ) 12. I'm always willing to try something new if I think it will be fun.
( ) 13. I often act on the spur of the moment.

Appendix B.
Implicit priming materials

B.1 Neutral condition

*Please read the following travel story and circle **all** "PYRAMID", "GIZA", AND "SPHINX" in the paragraphs.*

Pyramids of Giza and the Sphinx

The sole survivor of the Seven Wonders of the World, the Pyramids of Giza live up to more than 4000 years of hype. The Sphinx sits nearby, a 50m-long feline character carved from a single block of stone. If people want a peaceful view of the pyramids of Giza and Sphinx, taking a horse ride in the area at around 5pm is the best way.

The Pyramids at Giza are the planet's oldest tourist attraction. The wonder of the Pyramids lies in their age and in the twin mysteries of how they were built and what they were used for. The key sites to visit are Giza, closest to Cairo, and the day-trip sites of Abu Sir, Memphis, Saqqara and Dahshur. The oldest pyramid at Giza and the largest in Egypt, the Great Pyramid of Khufu stood 146m high when it was completed around 2600 BC. About 2.3 million limestone blocks, weighing around 2.5 tonnes each, were used in the construction of this giant. Although there is not much to see inside the pyramid, the experience of climbing through such an ancient structure is unforgettable. Along the eastern and southern sides of the pyramid are five long pits that once contained the pharaoh's boats. You can see one of the boats in the Solar Boat Museum.

Known in Arabic as Abu al-Hol (Father of Terror), the Sphinx is carved from the natural bedrock at the bottom of the causeway to Khafre's pyramid. Recent geological and archaelogical survey has shown that the Sphinx most likely dates from Khafre's reign, and probably portrays his features, framed by the striped nemes headcloth worn only by royal personages. Unfortunately the monument is suffering the stone equivalent of cancer, and recent restoration attempts have sped up, rather than halted, the decay. The cheesy sound and light show held near the Sphinx is a painless, albeit pricey, way to see the Pyramids by starlight.

*Please read the following travel story and circle **all** "PARK" and "AREA" in the paragraphs.*

Kgalagadi Transfrontier Park

Africa's first formally declared trans-border conservation area, the Kgalagadi Transfrontier Park, on the border of South Africa and Botswana, was officially launched on May 12, 2000. The Kgalagadi Transfrontier Park is located in Kgalagadi District approximately 865km south-west area of Gaborone. The combined land area of the Kgalagadi Transfrontier Park is +/- 38,000 km² of which 28,400 km² lies in Botswana and 9,600 km² lies in South Africa.

Transfrontier parks, border parks or transboundary conservation areas are protected areas that straddle international boundaries. The Kgalagadi Transfrontier Park is such a protected area in the southern Kalahari Desert. The southern Kalahari represents an increasingly rare phenomenon: a large ecosystem relatively free from human interference. The absence of man-made barriers (except to the west and south of the Park) has provided a conservation area large enough to maintain examples of two ecological processes that were once widespread in the savannahs and grasslands of Africa. The large scale migratory movements of wild ungulates; and predation by large mammalian carnivores. These processes are impossible to maintain except in the largest of areas, and their presence in the Kalahari makes the system of special value to conservation.

In addition to this, the Kalahari has a particular aesthetic appeal. The harsh, semi-arid environment has placed adaptive demands on both fauna and flora that are of considerable scientific interest. Few other conservation areas have attracted so many research projects. This research has revealed a widely fluctuating environment, driven by rainfall events, which vary widely in time and space. The significance of the Kgalagadi Transfrontier Park is that it is the first formally declared Transfrontier Park in Africa and it will hopefully serve as a model for conservation in the 21st Century. The Government of Botswana is keen to make the Transfrontier Park a success. The Peace Parks Foundation has played an important role in the development of the Kgalagadi Transfrontier Park and provides assistance for the creation of other transboundary conservation areas in the region.

B.2 Independent priming

*Please read the following travel story and circle **all** the pronouns (i.e., I, my, me, mine, we, our, ours, us, you, your, yours, they, them, their, theirs, it, its) in the paragraphs.*

Went to Alexandria (1)

My much awaited, short and hectic Egypt tour started on a low note. I arrived in Alexandria at 00.35 on 19th January, one hour late.

Alexandria was bone chilling cold when I walked out of the airport at 3 am. I almost felt like the chill of Manali in India! I didn't expect such weather, but it was ok. I hired a taxi, without negotiating too much, because at that time of the night in such weather, I want the cabbie on my side! My hotel, called Union Hotel was right on the cornice which is a lovely necklace shaped area. The first impression of Alex was that of a laid-back place and that was the final impression as well! Language was a barrier throughout my trip, but with a few Arabic words here and there, was able to manage quite well! The hotel guy was quite helpful even at 3 am, as I discussed with him my plan of action for the morning.

At 7 am, after breakfast, I headed for the nearby tram station. Cairo was setting in as I reached this massive city on the 18th of January. The first feeling that I got from the railway station was that it resembled Chennai Central station! Since I had lots to do and limited time, I decided to start off right away, and so, bag in hand, I hired a cab to see the Cairo Tower in the suburb island of Zamalek in Cairo. After settling an amount with the cab driver, I reached this massive 120 meter high tower, beautifully built in 1960. It was not a monument, but nevertheless, when I went to the top floor and looked over, I was floored. Stunning views of entire Cairo were on offer, and the timing was perfect. The street lights and the proceeding rays of natural light as twilight set in made my first impression of Cairo superb, I just couldn’t wait to see more.

*Please read the following travel story and circle **all** the pronouns (i.e., I, my, me, mine, we, our, ours, us, you, your, yours, they, them, their, theirs, it, its) in the paragraphs.*

Went to Alexandria (2)

Back on the road, my first stop was to hit the hotel and throw my bags into my room before I ventured any further. I was already having cramps on my shoulder due to carrying it all around, so I decided to not waste any more time. One more cab, more bargaining, fifteen minutes of a drive, and I was in front of Sun Hotel, my cute little budget accommodation for two nights in Cairo. When I mean budget, I mean it costs peanuts. Of course, peanuts cost far less, but trust me, it was cheap, around US$ 4 per night for a double room, without bath.

Now I don't know what I did right here, but my hotel was BANG in the middle of the action, in a place called Midan Tahrir. This place houses the famous Egyptian Museum (yes, the place with the mummies and King Tutankhamuns tomb and what not, but more on that later) and has the American University of Cairo nearby and it as such, one of the "happening" places in Cairo. Delighted with my luck, I checked into my room, and got out of the place, heading straight to Khan-E-Khalilil, one of the most famous market places in Cairo.

I explored this market, found out relative prices of souvenirs and stuff, prayed, and just soaked in the sights and sounds as massive loads of tourists from all over the world flocked the place for shopping. The next day was Eid, so even the local Egyptians were out on full force, enjoying the preparations for the big day ahead. Dinner was sheesh kabab, kofta, hummus (not the eating thing, but a new drink!) and something else. I thought the bill would be quite a bit, but when I saw it, was amazed! It cost just around 15 Egyptian Pounds (LE)! I was stuffed. At 2 am, I reluctantly decided to head back to the room, since the next day the Eid prayer was apparently going to be at 06:30.

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Fraser Island (1)

I Got up early Friday morning and went through the checklist of the equipment on the vehicle I had hired (a big 4.3 litre Toyota Landcruiser) for my trip to Fraser Island. After my briefing at my rental company, Safari 4 x 4 Rentals, I excitedly threw the kit into the beast and headed off toward Hook Point to catch my Big Barge where the adventure would begin. A 'very' pleasant lady both aesthetically and with a charming and friendly personality greeted me onto one of three barges competing for business. I grinned from ear to ear with excitement and after a short 15 minute crossing I landed and disembarked onto the thick, sandy beach at some speed (as this is how I was told to do it of course!)

After a short trip round a sandy track, I pulled on to something that loosely resembled a road, very loosely! The tarmac was worn out and pot-holes were all conquering. After what seemed like ages I arrived at the point where I was to join the beach – Eastern Beach Access. The tide was too high to travel any further at this point so I just had to wait. Out came the beers and the snacks, and the football…..I was only too happy to laze around for a few hours and watch the world go by! Joining the queue were other travellers waiting to head in the same direction as me and I made friends quickly.

After a few hours the tide was out enough to continue, so, in convoy I went up the beach heading for my first stop for the night, Indian Head. 2 ½ hours had passed before I arrived, and many toilet stops too for the beers were beginning to take effect, I roared up in the beast. I could see from the amount of people that were stuck that entering the campsite was no easy task…

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Fraser Island (2)

I woke up early, very hung-over. I put the stuff away, and attempted to drive up the beach a short way but had to return because the tide would have stranded me, so I instead decided to walk to a point called Champagne Pools some 3k's up the beach. I splashed around for a while and decided to head back to the beast. I head south along the beach for an hour until I found myself at a fantastic place called Eli Creek, a crystal clear, spring fed stream just 100 yards from the sea. From Eli Creek I headed further south to the shipwreck of The Maheno, a huge ship that was wrecked by storms as it was being towed for scrap in the early 1900's. Only 30 minutes down the beach I stumbled on some rock formations called 'The Pinnacles'. Quite bizarrely they looked like sandstone coloured road cones set into the rock but on a huge scale.

On the trip to my next campsite I stopped off at Lake Boomanjin for a dip. Lake Boomanjin is a perched lake, almost tea-coloured but still very pure. I had a dip and took off again round the rainforest track to the campsite called Dilli Village. The campsite was clean and the facilities were better than I expected – I had showers and water for a start. I pitched up and had a trot round to say hello to people and enjoyed some banter and again, a fair amount of grog then cooked myself what can only be described as awful. I called it Gruel and it consisted of everything I had left over, including beer and wine…

I grabbed a bowl and tucked in. It was so awful that I decided to go hungry and tidy up the mess in the morning. The morning came and it took at least an hour to sort out the mess I had 'created' previously' I packed up our bits and set off the 17k's to my next destination…

B.3 Interdependent priming

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Went to Alexandria (1)

Our much awaited, short and hectic Egypt tour started on a low note. We arrived in Alexandria at 00.35 on 19th January, one hour late.

Alexandria was bone chilling cold when we walked out of the airport at 3 am. We almost felt like the chill of Manali in India! We all didn't expect such weather, but it was ok. We hired a taxi, without negotiating too much, because at that time of the night in such weather, we want the cabbie on our side! Our hotel, called Union Hotel was right on the cornice which is a lovely necklace shaped area. The first impression of Alex was that of a laid-back chilled place and that was the final impression as well! Language was a barrier throughout our trip, but with a few Arabic words here and there, was able to manage quite well! The hotel guy was quite helpful even at 3 am, as we discussed with him our plan of action for the morning.

At 7 am, after breakfast, we headed for the nearby tram station. Cairo was setting in as we reached this massive city on the 18th of January. The first feeling that we got from the railway station was that it resembled Chennai Central station! Since we had lots to do and limited time, we decided to start off right away, and so, bag in hand, we hired a cab to see the Cairo Tower in the suburb island of Zamalek in Cairo. After settling an amount with the cab driver, we reached this massive 120 meter high tower, beautifully built in 1960. It was not a monument, but nevertheless, when we went to the top floor and looked over, we were floored. Stunning views of entire Cairo were on offer, and the timing was perfect. The street lights and the proceeding rays of natural light as twilight set in made our first impression of Cairo superb, we all just couldn’t wait to see more.

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Went to Alexandria (2)

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