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BEHAVIOURAL AND NEUROBIOLOGICAL EFFECTS OF CULTURAL ATTACHMENT

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Acknowledgements

"Giving birth is so difficult. Especially following many hours of unproductive pushing and laboring. In this case there were actually days and months of it. Some pregnancies dont go smooth; one needs to stay at the same room for hours and for days and months, not allowed to go out and drink and eat. Might start caring less for appearance and hating the person responsible for this situation and your life and everyone. Other mothers tell you not to worry about it, it not being so bad and that it is exciting etc. On the actual labor day you think you have everything ready for the hospital but of course many things are missing when you arrive. And then again need to push and push and many embarrassing things happen till you deliver."

-George Christopoulos

I would like to extend my greatest gratitude to everyone who helped me in the delivery of this thesis. It was a difficult but fun journey. There were many times that I came close to giving in and calling it quits but a very special group of people kept me hanging in there and played the most important roles in this thesis process. At the end of this journey, with the help of these people, I have grown from all the crying and smashing my head against the monitor in hopes that my ideas magically appear in text (and probably fatter as well). Before I begin the next chapter of my life, it seems appropriate that I finally give thanks where thanks are long overdue. Lets be honest, I will inadvertedly miss out somebody out so I apologize in advance if that person is you.

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executive centre. I will also miss sharing an office with George - how he turns out the light when I am in and walks away without realising, how I will hear random lines of Greek once in a while (probably cursing at Matlab), or how he has like 20,000 photos of me sleeping in the lab (no upload onto internet please).

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To iceiceice, disguised toast, the godly people at GGG, thank you for either keeping me sane so that I can finish everything or making sure that I took this long.

Lastly, to my partner in crime, boing boing.

“One might almost say that a culture is to a society,
as the memory is to a person”

Kluckhohn, 1954, pp. 694-695

“Feelings have not been given the credit they deserve
as motives, monitors, and negotiators of human cultures.”

A. Damasio, 2018, The Strange Order of Things

Contents

List of Tables

List of Figures

Summary

Cultural attachment (CA) suggests that individuals form attachment bonds to their culture, which, in a similar way to prototypical maternal figures, functions as an attachment figure. However, the effects of CA on human behavior and the related neurobiological responses are not well understood. The present thesis examines CA by firstly reviewing the related literature to elaborate on the current understanding of CA, in relation to theories and data from different disciplines. From the review, a conceptual model for cultural attachment is proposed by integrating several existing models. Following that, two affective priming studies were carried out to examine the neurobiological effects of the hypothesized sense of security obtained from CA. Study 1 measured the skin conductance responses (SCR) of individuals whilst Study 2 used functional magnetic resonance imaging to measure the blood oxygen level dependent responses in the brain. Subliminally presented home cultural symbols were found to mitigate stress responses to threat and aid in emotion regulation. In particular, the presence of home cultural symbols reduced the typical increase in threat-related SCR suggesting that the threat-related arousal was affected. The second study found that, when under threat, the left dorsolateral prefrontal cortex (LDLPFC) - an area involved in emotion regulation acted in a similar fashion: higher LDLPFC activity due to threat was reduced in the presence of home cultural symbols. Other individual differences, such as need for cognitive closure and particular aspects of cultural attachment, were found to moderate the effectiveness of home cultural symbols in mitigating threats. Overall, this thesis provides converging multimodal evidence of the effects of CA and cultural symbols on threat mitigation, thus setting the basis for potential emotional mechanisms that could explain how cultural symbols can act as extensions of prototypical attachment figures.

Chapter 1

Introduction

Picture this. Having moved to a new country or city, you feel threatened by the uncertainty of the place, people, and practices. How would you cope? People respond differently in the face of threat and their ability to successfully navigate the challenges posed by their environment is closely tied to their survival and fitness. Individuals have long learnt to leverage on social mechanisms (such as culture) to aid them in mitigating and overcoming different types of threats. For example, local staples such as bottles of kaya (a coconut jam primarily found in Southeast Asia), sambal chilli sauces, and packets of bak-kwa (honeyed barbecued pork) are commonly found in the bags of many Singaporeans going abroad for an extended period of time. In fact, such behaviour can be observed in people from all over the world. Food is one of many tangible aspects of culture which can differ greatly even in places of close geographical proximity. Anecdotes of these travellers will detail how these food items and other objects help cure their homesickness and comfort them. Similarly, encountering another fellow countryman or other representations of one's home culture brings about a familiarity that can also be comforting. These different manifestations of culture act as symbols which remind us of the culture itself. The far-reaching influence of these cultural symbols indicates that there is an apparent emotional bond between individuals and their culture. Researchers likened this emotional bond to ones shared between children and their caregivers (Hong et al., 2006, 2013) and named this bond - cultural attachment.

As the world becomes more globalised, geographical boundaries are broken down by long and short term migration of humans from different cultures. Contemporary research into culture is promoted by the sometimes stark differences between these cultures. Many features and benefits of culture have been examined across numerous fields such as anthropology, sociology, political science, psychology, biology, and neuroscience. However, many of these benefits remain understudied. Cultural attachment is one such example. Similar to attachment bonds to caregivers and other adults, cultural attachment provides psychological security to aid in the defence of imminent threats. Cultural attachment works in a two-pronged approach with the individual seeking comfort and security from other members in the same cultural group and from the abstract representation of culture in their minds. Scholars have previously highlighted the importance of affectional bonds between the individual and other members of the cultural group (Chao et al., 2015) and also shown that culture is held by mental memory networks which become accessible when primed (Hong et al., 2000; Hong and Khei, 2014). To date, although many similar ideas have been brought up, only a handful of papers have presented effects of cultural attachment in threat mitigation (e.g. Hong et al., 2013). While it was clear that the presence and salience of cultural symbols moderated (reduced) the threat responses of individuals, 1) the biological responses of individuals, and 2) the mechanisms behind the mitigation process remained unclear (see Figure 1.1).

The research conducted in this thesis aimed to fill the research gap by establishing the biological traces of threat mitigation from cultural attachment and uncovering the possible mechanisms behind the process. Figure 1.2 shows a summary of the approach taken in this thesis. In Chapter 2, I built on and reinforced early work

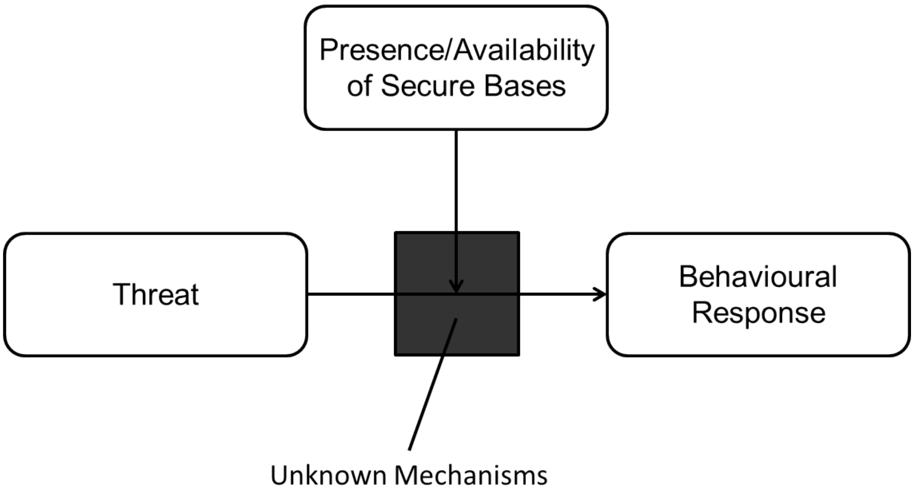

Figure 1.1: The current model of attachment.

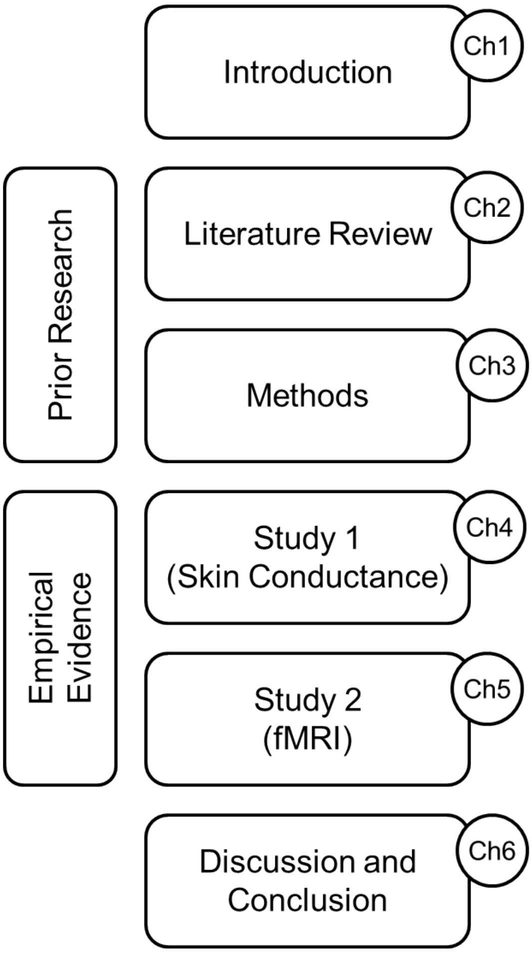

Figure 1.2: Flowchart of the chapters in the thesis.

in the nascent field of cultural attachment by reviewing and aligning the literature in culture, attachment, cultural attachment, and social affective neuroscience. Detailed and narrowed research questions are established by the end of Chapter 2. Attachment is a biobehavioral state in which several physiological and behavioural systems are organized in order to provide an individual with a certain sense of security and intimacy with significant others (Bowlby, 1969; c.f. Gander and Buchheim, 2015). The major tenets and developmental history of attachment theory (AT) applied in this thesis can be found in chapter 2.2. The positive effects of having strong secure attachment bonds to ones caregivers were found in the body and the brain. Since cultural attachment is based on AT, it is meaningful to examine the body and brain for multimodal evidence to support the robustness of the phenomenon. In particular, there is a focus on the emotion regulation effects from cultural attachment. Following from the somatic marker hypothesis (Damasio, 1996), which states that there are markers in the body and brain associated with the emotions felt, using those markers provide a more unbiased measurement of emotional change. In the same chapter, a conceptual model was also proposed by adding details from prior work done in the different fields to the simple model (Fig 2.2). Although not all aspects of the model were tested in this thesis, a wide range of techniques (such as subliminal priming, attention tracking, and affective transfer) were used. The reasoning behind the choice of techniques are detailed in Chapter 3 which also contains the preparation of experimental stimuli and the different statistical analyses used. Subsequently, I provided robust empirical evidence of the different aspects of cultural attachment by obtaining multi-modal evidence using two different experiments. Study 1 (Ch 4) uses the skin conductance response (SCR) of individuals in an affective priming task in which participants were shown different cultural stimuli paired with stimuli of different threat levels. SCR is a psychophysiological measure of bodily responses to threat and fear and was used to detect if the body responds differently in any of the experimental conditions. Study

2 (Ch 5) uses functional magnetic resonance imaging (fMRI) to measure neural responses of individuals during a similar affective priming task. Brain responses in regions associated with threat detection, threat processing, and emotion regulation were examined to detect the impact of cultural symbols. A general whole brain analysis was also performed to identify other potential areas that could be related to cultural attachment. Chapter 6 summarizes the findings from both studies, discusses their impact, and evaluates their contribution in answering the research question. At the same time, potential future research and limitations of the studies are also discussed.

Chapter 2

Literature Review

In this chapter, I will review important literature behind the development of cultural attachment and its possible neural basis. These include a brief introduction to cultural attachment, its roots in dynamic constructivist theory of culture and attachment theory, as well as possible biological systems which have a part to play in this process. Following that, I will propose a conceptual model which captures the different aspects discussed in this chapter as well as discuss possible moderators and confounding constructs.

2.1 Cultural Attachment

Cultural attachment was developed as an extension of AT because the acculturation process bears similarities to an infant being born (Hong et al., 2006, 2013). When an individual is introduced to a new culture, he/she is introduced to different norms, values, beliefs and structures. The presence and reminder of home culture is believed to provide the individual with security to explore and better regulate his/her emotions in the new environment (Hong et al., 2016; Fu et al., 2015). In fact, there is initial evidence that maternal, paternal, and cultural attachment affect different aspects of intercultural adjustment (Phua et al., 2017). One of the initial inspirations for examining the effects of the emotional bond towards culture stemmed from the similarities from the classifications of attachment styles (Bartholomew and Horowitz, 1991), acculturation styles (Berry, 1990, 1997) as well as the attachment to groups (Smith et al., 1999) and adult attachment styles (Brennan et al., 1998). Berry's acculturation strategies (assimilation, separation, integration, and marginalization) were posited to be linked to the different adult attachment styles (secure, preoccupied, dismissing, and fearful). Individuals had a different attachment style to their home and host cultures and different combinations of those resulted in different acculturation strategies (Hong et al., 2013). Similarly, Smith and colleagues (Smith et al., 1999) observed that attachment to groups followed two dimensions: anxiety and avoidance. Brennan and colleagues (Brennan et al., 1998) had previously measured adult romantic attachment using the same dimensions.

2.1.1 Attachment Theory

AT was initially developed by John Bowlby and Mary Ainsworth to describe the relationship and bond between a child and his/her caregivers and how that relationship affects the child's development as well as cognition (Bowlby, 1969; Ainsworth and Bowlby, 1991). Attachment refers to the unidirectional (and only sometimes reciprocal) emotional bond that an individual has to an attachment target. Traditionally, this target usually refers to the primary caregiver of the child - the mother. In the later development of the theory, researchers have extended the scope to other targets such as significant others, countrymen, non-human animals or non-living objects (Keefer et al., 2014).

Over the last thirty years, AT has contributed greatly to research in social and emotional development of humans. The reach of AT is widespread and its literature originates from many different fields, such as developmental psychology, evolutionary psychology, social psychology, neuroscience, psychophysics, and ethology. Detailed progress behind the theory and its historical timeline can be found in several comprehensive reviews (Bretherton, 1985; Bretherton and Munholland, 2008; Mikulincer and Shaver, 2003; Cassidy and Shaver, 2016; Bowlby, 2008). For the purposes of this thesis, I shall focus on two of the many tenets established in AT: the internal working model and the function of attachment targets as secure bases.

2.1.2 Attachment Theory: Internal Working Models (IWM)

An IWM refers to the cognitive framework comprising of mental representations based on the individual's experiences (Bowlby, 1969, 1973, 1980)[1]. Although not stated formally, one can argue that a dynamic constructivist view of culture consists of IWMs of culture. In AT, these relate to representations of the self, others, and their relationship. Early experiences with the caregiver form a basis for an IWM of social relationships. As children interact with their caregivers, their experiences accumulate and expectations about each role (e.g. the self, the caregiver, and the accessibility and responsiveness of the caregiver) are constructed (Bowlby, 1969). In later social interactions, memories and information processing frameworks formed from previous interactions provide the child with guidelines (Bowlby, 1969; Bretherton and Munholland, 2008), even as the child progresses into adulthood (Hazan and Shaver, 1987). The IWMs of two to six year olds are reportedly sophisticated, their schemas about others are fairly accurate and these children are able to develop an understanding of precise and complicated rules of social interactions (Bretherton, 1993; Cassidy et al., 1992; Dunn, 1993; Main et al., 1985;

[1] Although similar to the concept of schemas (Piaget, 1952) and sometimes used interchangeably, researchers such as Pietromonaco and Barrett (2000, pp163) have argued that "the working models concept reflects more motivated, dynamic, affectively charged processes".

Greenberg and Marvin, 1982; Miljkovitch et al., 2004; Nelson and Gruendel, 1981; Slough and Greenberg, 1990; Stern, 1985; Waters and Waters, 2006).

IWMs are dynamic across time and need to be updated to ensure their stability and continuity (Bowlby, 1969, 1982; Bretherton and Munholland, 2008). In fact, some researchers have associated IWMs with the stage of development of the brain, specifically its memory and socio-cognitive capabilities (Thompson, 2000, 2006). Examples include the emergence of theory of mind where the child is able to attribute mental states to others or event representations of episodic memories where the child remembers and recalls details of separate events. As the brain develops, representations are also updated and the number of different ways of understanding the same experience increases. For example, secondary representations of experiences mediated by language or affect change as the capabilities of the child improve. In fact, it has been shown that the attachment attitudes and styles of preschool children are better predictors of adult attachment than their infant attachment styles (Thompson, 2006, 2015). Researchers have also suggested that the attachment structure of adults in their middle or later stages of their life is different from younger adults. Specifically, principal component analysis performed on the Relationship Style Questionnaire revealed seven factors in older samples in comparison to the three that were originally proposed (Magai, 2008). This suggests that IWMs become more complex and nuanced as individuals age.

However, once IWMs stabilise, they are not entirely malleable. Bowlby (Bowlby, 1973, 1980, 1988) believed that once defensive mechanisms are established in a child's IWM, positive changes are difficult to instill. This is supported by selective processing by insecurely-attached adults where they have a tendency to suppress or exclude attachment-related information regardless of the valence of the information (Dykas and Cassidy, 2011; Mikulincer and Shaver, 2007a, 2011). Critically, only attachment related information seemed to be consistently overlooked and general information processing was not affected (Mikulincer and Shaver, 2007b). Other researchers revealed that securely attached children generally paid more attention to positive events (Belsky et al., 1996). This suggests that there could be inertia in the initial state of the IWM. Securely attached individuals are in a positive cycle to seek and absorb attachment related information whilst insecurely attached individuals are in a negative cycle to reject and avoid attachment related information. On top of that, attachment is naturally a dyadic bond. In long lasting relationships, the IWMs of both parties have set expectations of the other. Changes in the behaviour of one party may be met with resistance from the other party resulting in the maintenance of the status quo.

Further, stable and continuous attachment relationships are likely to result in strong secure attachment bonds (Belsky and Fearon, 2002; Egeland et al., 1990; Sroufe et al., 1990). Strong secure attachment bonds, once formed, are not easily displaced. For example, an individual is unlikely to completely lose faith in the attachment figure just because the emotional sensitivity of the attachment figure lowers for a few interactions. In line with Piaget's (1976) idea of assimilation, these individuals are not alarmed by sporadic lapses in consistent behaviour from the attachment figure. On top of that, familiar relationships demand less attention and are more likely to be automated. This is in line with the idea that individuals prefer to maintain familiar relationships to reduce the cognitive effort needed for social interaction otherwise (Coan and Sbarra, 2015). However, this lack of attention leads to the slow updating of IWMs.

2.1.3 Attachment Theory: Secure Bases

The idea that attachment targets could act as secure bases was first introduced by Ainsworth (1963) after observing interactions of children and their caregivers in the Strange Situation. “Secure base schemas”, which is a set of expectations about the accessibility and responsiveness of the attachment target (Sroufe and Waters, 1977a; Waters et al., 1998; Mikulincer et al., 2001b), set up if-then conditions that provide individuals with scripts (e.g. If I am threatened, I can approach this person and he/she will be there for me) when they are under threat. These scripts are posited to create a sense of felt security (Sroufe and Waters, 1977a; Waters and Cummings, 2000; Waters and Waters, 2006). In childhood attachment, secure bases act as anchors for children to explore their environments and a safe haven to retreat to when threatened (Ainsworth et al., 1978; Waters et al., 1998; Feeney, 2004). A secure attachment is a necessary condition for the attachment target to act as a secure base. In the case of a caregiver-child relationship, the child must sufficiently trust that the caregiver will be physically accessible and emotionally available before the child would view the caregiver as a secure base. Other researchers have also described secure bases as a manner of social regulation on emotional processing (Beckes and Coan, 2015). Similar results were also shown with research in adults (Mikulincer et al., 2001a, 2002b). Additionally, these “if-then” scripts also allow for symbolic representations of the secure base to grant a similar safe haven and reduce the anxiety of the individual (Mikulincer et al., 2001b, 2002a). Social bonding research also contributes by suggesting that humans tend toward affiliation (Depue and Morrone-Strupinsky, 2005) and recognise signals of social closeness readily (Laird and Strout, 2007; Rolls, 2007).

Several experiments using an affective priming paradigm (discussed in greater detail in the methods section), where participants are first threatened and then exposed to their secure base, have shown that symbolic representations (such as a painting of a mother holding a child or a well-known cultural landmark) are also effective (Mikulincer et al., 2001b, 2002b; Mikulincer and Shaver, 2001; Hong et al., 2013; Eisenberg et al., 2011; Beckes et al., 2010; Banse, 1999, 2001). This is an important finding because it introduces a way to systematically test the efficacy of attachment in adults and aids the extension of attachment to other domains, as cognitive representations introduce a meaningful way to discuss attachment to intangible aspects. This is elaborated in further sections when attachment targets are sometimes abstract or imaginary.

Other experiments also examine the efficacy of having secure attachments and secure bases. Securely attached individuals have a lower tendency to perceive stressful situations as threatening (Mikulincer and Florian, 1995). Additionally, they are more open to seeking help when feeling distressed (Mikulincer et al., 2009). There is a higher willingness for securely attached individuals to trust others, even in previously damaged relationships (Mikulincer, 1998) or with members of an out-group (Mikulincer and Shaver, 2001). Securely attached children with better quality of interactions with their caregivers tended to develop better emotional understanding (Laible and Thompson, 1998; Ontai and Thompson, 2002; Steele et al., 1999; Raikes and Thompson, 2006; Thompson and Meyer, 2007; Beckes and Coan, 2015). In the same vein, daily conversations with children about their experiences have been found to improve emotion regulation as well (Wareham and Salmon, 2006). Cassidy and colleagues (Cassidy et al., 1996) showed that securely attached children ascribed benign motives to story characters whilst insecurely attached children inferred hostile intent. Secure attachment also exhibited links with higher self-esteem (Cassidy et al., 2003; Doyle et al., 2000; Kerns et al., 1996; Sharpe et al., 1998; Verschueren and Marcoen, 2002, 2005; Yunger et al., 2005; Harter and Pike, 1984), higher social competence (Denham et al., 2002, 2001;

Schneider et al., 2001; Kerns et al., 2007), and more positive self-concept (Doyle et al., 2000; Cassidy, 1988; Verschueren et al., 1996). Similar trends are also present in research of rhesus monkeys showing that their young explore more in the presence of their mothers as well and return to their mothers when frightened (Dienske and Metz, 1977; Harlow and Harlow, 1965; Simpson, 1979).

2.1.4 Cultural Attachment: IWM and Secure Bases

Cultural attachment is proposed to follow a two-pronged process in which individuals are attached to the members of the cultural group and to the abstract symbolic representations of the culture (Hong et al., 2013, 2006). Following from the arguments of children being attached to multiple targets, including other family members (Weisner et al., 1977; Puddy et al., 2003), romantic partners (Hazan and Shaver, 1987; Mikulincer et al., 2001a), organizational members (Davidovitz et al., 2007), fictional characters, pets (Sable, 2013), deities (Kirkpatrick, 2005; Granqvist et al., 2007), places (Scannell and Gifford, 2010; Lewicka, 2011; Scannell and Gifford, 2017), and even objects (Keefer, 2016), the cultural group and its associated symbols can be viewed as an extended group of caregivers and attachment targets.

Culture is posited to have existed since early humans banded together in groups of varying sizes to become more effective and efficient at ensuring their individual and collective survival. The formation of cultural groups also helps to reduce physical and social environmental uncertainty (Grieve and Hogg, 1999). Important elements of culture (e.g. knowledge, shared meanings, unique languages, practices, social rules and expectations) can facilitate and speed up the exchanges of people who need to frequently interact, share resources, and swap tangible and intangible assets (Christopoulos and Tobler, 2016). Further, repeated interactions between members of the same group lead to the predictability of behavior and expectations which in turn aid in future interactions. Some of the other functions of culture include differentiated roles, providing social support but also social control, sharing cognitive orientations and goals, as well as regulating affective expressions (Kluckhohn, 1954). Cultures have also been found to ascribe meanings and frameworks to understand the world, together with a sense of epistemic security and certainty to its members (Pyszczynski et al., 2004). Individuals form emotional connections with other members in their social group, the social group itself and eventually its abstract representations (Smith et al., 1999). Cultural groups are posited to protect against outgroups and other forms of threats. The security provided goes beyond the physical aspects and stretches into the emotional aspects as well (Chao et al., 2015). As such, culture can be seen to act as a secure base to individuals who are securely attached.

Culture is a complex network of shared meanings (Hong, 2009) that is difficult to represent in the same way typical attachment figures (such as the mother) are mentally represented. In other words, some aspects of cultural attachment have to be formed based on the intangible nature of culture (Becker, 2013; De Berker et al., 2016). The cognitive framework of cultural attachment, predominantly based on symbolic representations such as flags, objects, places, statues etc., could be activated when such symbols were shown (Hong et al., 2000). For example, the term “motherland” itself could act as a mnemonic for the nation (Diener, 2002). In order to reliably activate this cognitive network, a dynamic constructivist approach to culture is used. Under the dynamic constructivist approach, an associative memory network containing culturally relevant information (such as norms, beliefs and values) can be activated to influence cognition and consequently, behaviour (Hong et al., 2000; Hong, 2009; Briley et al., 2000; Wyer Jr, 2014; Briley and Wyer Jr, 2001). This is a process known as cultural priming. Priming an individual involves using stimuli or tasks to activate mental representations to serve as frames of references for future tasks (Bargh and Chartrand, 2000; Higgins, 1996). Various types of priming, using a range of mediums (such as words, images, or other sensory information), are used to achieve different goals. In general, perception of certain stimuli will activate networks related to that stimuli and lead to behavior congruent to that of the stimuli (Dijksterhuis and Bargh, 2001). For example, sales of French and German wines in a supermarket were found to fluctuate based on whether French or German music was being played (North et al., 1999).

Here, more emphasis is placed on the individual's perception of cultural information and the cultural identity, or identities in the case of bicultural individuals, of that person. Cultural priming involves priming individuals to remind them of their cultural background by using culturally relevant stimuli such as images unique to that culture, words commonly associated with that culture or a language primarily used in that culture (Fu et al., 2007a,b; Ross et al., 2002; Trafimow et al., 1991; Verkuyten and Pouliasi, 2002; Hong et al., 2000, 2013; Briley and Wyer Jr, 2001; Chen et al., 2005; Briley, 2008; Briley et al., 2005). This is evident from the research in bicultural individuals (who have been exposed to two cultures extensively) who displayed an ability to -consciously or not- switch cultural frames when making decisions (Hong et al., 2003, 2000). A natural extension of the dynamic constructivist approach is the development of polyculturalism which posits that cultural traditions are shared amongst different cultures, and individuals are partially influenced by different cultures (Morris et al., 2015). Despite the many cultural constructs or networks of information, priming makes a specific cultural construct accessible to the individual and has been shown to influence decision making in contexts where the construct is applicable (Hong et al., 2003). For example, there is evidence that bicultural individuals are cooperative towards ingroup members when primed with a more collective identity and less cooperative when primed with an individualistic identity. However, the same level of cooperation cannot be found if the target was instead an outgroup member (Wong and Hong, 2005).

In the development of cultural attachment, particular focus was placed on bicultural individuals - individuals who have been exposed to two cultures extensively. Using cultural priming experiments involving bicultural individuals, researchers (Fu et al., 2007a,b; Hong et al., 2003, 1997, 2000; Ross et al., 2002; Wong and Hong, 2005; Chiao et al., 2010; Trafimow et al., 1991; Verkuyten and Pouliasi, 2002; Ng and Lai, 2009; Sui et al., 2007; Tam et al., 2012; Elaine Perunovic et al., 2007) were able to examine the fluidity of cultural frames and the existence of separate cognitive frameworks for each culture. Different cultural symbols seem to be capable of activating their own respective frameworks, supporting the notion that there is a mental representation network associated with each culture. These mental representation networks possibly form part of an IWM. Similar to arguments made in polyculturalism, individuals can be attached to more than one culture and secure attachment towards either culture aided in predicting that individual's levels of resilience towards threats (Hong et al., 2013).

Individuals from different groups were categorised based on home and host country criteria. The home country is defined as the country that individuals have spent their formative years in, whilst the host country is defined as the country that these individuals are currently residing in. Additionally, the term “Americans” in this thesis refers to citizens of the United States of America and “Chinese” refers to citizens of the People's Republic of China. Once again, it is important to note that although national boundaries often divide different cultural groups, cultural differences often transcend these physical boundaries. Attempts to mitigate this limitation include reaffirming the cultural identity and their recognition of cultural images used in the studies.

2.1.5 Moderators and Confounds

In previous studies of cultural attachment, several moderators and confounds were theorized and tested to contribute to the success of cultural stimuli. These included several social psychological constructs that are related to security or intergroup dynamics. In this thesis, I plan to examine the effects of need for cognitive closure, racial essentialism, parental attachment, and adult attachment; as well as control for the effects of group identity, patriotism, familiarity of the stimuli and the baseline emotional state of the participant. For samples of individuals who are not currently in their home country, I also control for the effects of acculturation stress and perceived racism.

Individuals with higher need for cognitive closure (NFC; Kruglanski, 1989; Kruglanski and Webster, 1996; Webster and Kruglanski, 1994) were more receptive of cultural symbols and thus improving acculturation (Kosic et al., 2004; Yeh and Inose, 2003). When these individuals move to a new culture, there seems to be a higher likelihood for them to “seize” and “freeze” on home cultural stimuli which bring them comfort. On top of that, according to the terror management theory (Pyszczynski et al., 2004), which discusses the conflict between self-preservation and the capability of humans to realise their own inevitable mortality as well as the actions taken to manage this conflict, it is suggested that acting in line with the standards of culture creates meaning for the individual (Becker, 1971). Individuals with higher need for cognitive closure can be expected to respond more strongly to secure base stimuli than individuals with lower need for cognitive closure.

An essentialist belief of race (as opposed to a constructionist belief) implies the belief of an underlying essence of race which leads to specific dispositions associated with each race (No et al., 2008). Individuals with these beliefs were more likely to perceive other countrymen who were of a different race as being more different from themselves (No et al., 2008) and were more likely to make rigid racial categorizations of individuals (Chao et al., 2013). A mechanism proposed for the link between essentialist beliefs and more rigid racial categorization is need for cognitive closure (Roets and Van Hiel, 2011b). Additionally, children with essentialist beliefs were unable to remember racially ambiguous faces as well as other children (Gaither et al., 2014). On the other hand, social constructionist beliefs have been discovered to facilitate intergroup trust (Kung et al., 2018). Individuals with more essentialist beliefs can be expected to respond more strongly to secure base stimuli than individuals with more social constructionist beliefs.

The explanation provided to propose that cultural attachment is the mechanism behind threat mitigation using cultural stimuli can be challenged by several similar concepts. It is difficult to test all possible concepts for discriminant validity so I have included the ones that seem to have a larger overlap. I argue that many of the confounding variables listed here are necessary but not sufficient conditions for security to be felt from a cultural stimulus. The first of such confounds is group identity. Group identity (operationalised as cultural identity) suggests that the membership of individuals in certain groups enhances their loyalty and positive feelings to that group and in contrast, increases their negative feelings towards members outside of the group and of other groups (Tajfel, 1974, 2010). Similar to group identity is patriotism, which is the love and devotion for ones country. The categorization of culture in this thesis is based on the nationality of the participants so it is necessary to find out if the results observed are tightly linked to patriotism.

Another possible confound in the familiarity of the stimuli. Familiarity of a certain set of stimuli can bring about positive emotions which would provide a buffer against any negative ones. Specifically, researchers have suggested that nostalgia, the sentimental longing of ones past, can also induce positive emotions (Sedikides et al., 2004, 2008). Through the study of nostalgia, we observe that if the individual does not have an emotional bond to the familiar object or person, there might not be any positive emotion induced. In other words, the emotional bond (which can be seen as the attachment bond) forms the basis for nostalgia. In my conceptual model which I discuss later on, there is a recall component in attachment which triggers the positive emotions. However, nNostalgia and familiarity seem to cover less ground than attachment in that aspect. In the same vein to familiarity is the thought of social support. The effectiveness of the thought of social support is dependent on the value of the emotional bond between the source and recipient of the social support. The last possible confound is the emotional state of the participant on the day of the experiment. Since the measures employed in this thesis are contingent on emotional responses of the participants, if the participant is in an extremely good or bad mood, the results could be influenced accordingly.

Participants who are not in their home country might experience increased levels of stress from the need to adapt to the new environment (Berry, 2006). Since the paradigms used in this thesis involve evoking threat response, the baseline stress levels of the participant might affect their responses. An additional source of stress comes from negative interactions with host country citizens. Perceived racist behaviour suggest hostility from the host country and might affect perceptions of cultural groups which in turn leads to stronger in-group identity (Clark et al., 1999; Kaholokula et al., 2012). Cultural attachment was found to be associated with lower levels of acculturation stress and perceived racism (Hong et al., 2013).

2.2 Attachment And Culture in the Brain And Body

Cultural attachment is a nascent topic and the neuroscience of cultural attachment has not been previously researched. Following from the previous section, the current state of biological research in attachment is used as a starting point. This section reviews current literature in the psychophysiology and neuroscience of attachment in order to determine the underlying mechanisms of cultural attachment. After a basic introduction of the human nervous system, the remainder is structured with the tenets of AT in mind. Once again, the focus will be on IWMs (cognitive framework) and the emotion regulation effects of secure bases (affective).

2.2.1 Human Nervous System

The human body is constantly responding to its environment in conscious and subconscious ways and engages the nervous system in doing so. Structurally, the nervous system consists of two main parts, the central nervous system (CNS) and the peripheral nervous system (PNS), and transmits signals to and from different parts of the human body in order to coordinate and execute actions. The CNS consists of the brain and spinal cord while the PNS consists of the remaining nerves that connect the rest of the body to the CNS.

2.2.1.1 Peripheral Nervous System

The PNS comprises of the somatic, autonomic, and enteric nervous systems. The somatic nervous system acts under voluntary control and comprises of the somatosensory system and sensory nervous system. On the contrary, the autonomic and enteric nervous systems are self-regulating systems that influence organ functions outside of voluntary control. While the enteric nervous system solely governs the function of the gastrointestinal tract, the autonomic nervous system (ANS) controls most other parts such as the bladder, heart, and skin. The ANS is controlled by the hypothalamus which receives information from the rest of the limbic system (which contains brain structures involved in motivation, learning, emotion, and long-term memory) to regulate ANS activity (McEwen, 2007). An example of how the hypothalamus regulates stress in the body is through glucocorticoid release (the main glucocorticoid found in humans is cortisol) via the hypothalamic-pituitary-adrenal (HPA) axis (Kemeny, 2003; Dickerson and Kemeny, 2004). The sympathetic and parasympathetic systems are two subsystems of the ANS which act on ”fight or flight” and ”rest and digest” situations respectively. The sympathetic system supports stress responses to, predominantly, threatening events as it also orients the body towards rewarding stimuli. Common biomarkers used to measure the sympathetic system include heart rate, sweating, breathing, and eye-blinking patterns.

One of the most commonly used biomarker of arousal is the skin conductance response (SCR) which is derived from electrodermal activity (EDA; see Boucsein, 2012 for a detailed review, see chapter 3.12.2 for further elaboration). EDA is the general term used to describe electric phenomena happening on the skin due to sweat secretion. EDA can be further divided into skin conductance level (SCL) and skin conductance response (SCR). SCL, also known as the tonic component of skin conductance, is the underlying skin conductance that is not affected by any stimulus. SCR, also known as the phasic component of skin conductance, is typically event-related and spontaneous. Additionally, threat-elicited SCR was shown to be mediated by amygdala activations (Wood et al., 2014). Researchers have used SCR to study a variety of topics, such as group differences in decision making and responses towards threats (e.g. Armel and Ramachandran, 2003; Crone et al., 2004; Figner et al., 2011; Jacobs et al., 1994; Syngelaki et al., 2013b,a; Dawson et al., 2011; Peterson et al., 2010; Bulganin et al., 2014; Staib et al., 2015), assessment of pain (Ledowski et al., 2007; Storm, 2008), schizophrenia (Raine et al., 1999; Yamamoto and Hornykiewicz, 2004), peripheral neuropathy (e.g., Polo et al., 2000; Torigoe et al., 1999), indicators of social abilities and social distress (Esposito et al., 2016; Truzzi et al., 2016; Hein et al., 2011).

2.2.1.2 Central Nervous System

On the other hand, the relatively more complex structure of the brain consists of three major sections: cerebrum, brainstem, and cerebellum. The cerebrum, which is the largest of the three, comprises of an outer layer known as the cortex which covers inner structures such as the basal ganglia and hippocampus. There are four major cortical lobes: frontal, parietal, temporal, and occipital (as shown in Figure 2.1, pg24). The frontal lobe contains areas such as the prefrontal cortex (PFC) and anterior cingulate cortex and has been associated with emotional processing (Ochsner et al., 2012), decision making (Bechara et al., 2000), cognitive mentalizing (Lieberman, 2007), emotional mentalizing (Lieberman, 2007), and social preferences (Zaki et al., 2013). The parietal lobe contains areas such as the posterior cingulate cortex (PCC), angular gyrus, precuneus and temporoparietal junction (TPJ), which are associated with social behaviour (Lieberman, 2007), decision making (Greene et al., 2001) and emotional mentalizing (Glenn et al., 2009).

The temporal lobe consists of regions associated with emotion and emotion regulation such as amygdala and insula as well as regions associated with memory such as the hippocampus (Wicker et al., 2003; Singer et al., 2004; Brasted et al., 2003; Kennedy and Shapiro, 2004). Lastly, the occipital lobe comprises mostly of areas associated with vision. The basal ganglia comprise of areas such as the striatum, pallidum and substantia nigra, and are connected to the brainstem. The brainstem

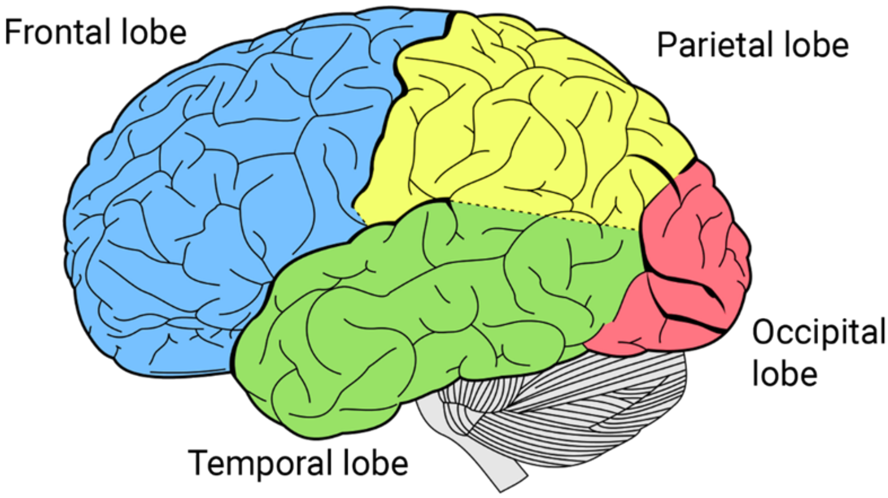

Figure 2.1: Four Major Lobes of the Brain.

connects the brain to the spinal cord and comprises of the midbrain, pons and medulla oblongata. Of interest here is the midbrain which contains areas related to reward processing such as the previously mentioned substantia nigra and the ventral tegmental area (VTA).

The last area, the cerebellum (latin for “little brain”) is connected to the rest of the brain via the pons and is located behind the pons and medulla. The cerebellum functions in tandem with different parts of the cerebrum in motor, cognitive, and social tasks (Stoodley and Schmahmann, 2009, 2010, 2016; Hoche et al., 2016).

Throughout the brain, there are about several billion cells, with most of them being neurons and neuroglial cells. Neurons process and transmit information by using electrical and chemical signals (also known as neurotransmitters) while neuroglia support and protect them. The more neurons fire simultaneously, the more likely they are to be functionally “wired” together. These “wires” across different parts of the brain form neural pathways. Neural pathways in which some of these neuro-transmitters transmit information through have been shown to be crucial in specific functions (e.g. dopaminergic pathways have been shown to be related to reward and motivation; Pessiglione et al., 2006; Christopoulos et al., 2009; Bromberg-Martin et al., 2010).

2.2.2 Neural models of attachment

Processes relating to the formation and maintenance of attachment bonds are complicated and difficult to detail. As a result, dedicated neural circuits of attachment have not been isolated and in fact, posited to not even exist (Coan, 2008, 2016). Instead, it is proposed that attachment is a higher-order culmination of different existing networks in the brain (Coan, 2008, 2016). This is in line with Bowlby's (1969) description of attachment being a "biobehavioral state in which several physiological and behavioural systems are organized in order to provide an individual with a certain sense of security and intimacy with significant others" (c.f. Gander and Buchheim, 2015, pp1). Similarly, due to the multi-determined nature of psychophysiological measures, dedicated circuits for bodily responses reflecting attachment bonds have also not been identified (Fox and Hane, 2008; Buchheim et al., 2017). However, several reviews bridging research in attachment to the brain and the body (e.g. Coan, 2008, 2016; Gander and Buchheim, 2015; Vrticka and Vuilleumier, 2012) have proposed possible models of how attachment functions. In particular, the two models (Coan, 2016; Vrticka and Vuilleumier, 2012) detailing how attachment is represented in the brain both highlighted the cognitive and affective elements of attachment and structured their models around the corresponding areas in the brain.

Coan (2016) proposed an example of how different networks in the brain would work together to identify, maintain and benefit from attachment bonds. Many parallels can be drawn between the suggested model and the functioning of an IWM. Reward processing regions of the brain (such as VTA, nACC, striatum) release dopamine when in contact with a secure attachment target and the amygdala tags the experience as emotionally salient before long term memory consolidation in the hippocampus. As multiple memories form, a consolidated semantic understanding of the attachment target is formed and used whenever primed or reminded of him/her/it. Upon recall, the same reward processing networks release dopamine again aiding in emotion regulatory regions (such as various parts of PFC, ACC) in exercising top down regulation of affective regions of the brain experiencing threat or other negative emotions. Social cognition regions of the brain contribute to this process by identifying “rewarding” attachment targets and by promoting behaviours that outsource the cognitive load of emotion regulation to them. At the same time, the brain reinforces rewarding choices and avoids negative ones.

Vrticka and Vuilleumier (2012) proposed a push-pull model between social approach and social avoidance (also known as the affective evaluation of the relationship) where secure attachment generally promotes social approach and vice versa. In their model, relatively basic and automatic affective evaluations are influenced by more elaborate cognitive control processes (such as emotion regulation and mental state representation). An example is ability to think like another person and represent the other person’s mental state in one’s brain, also known as theory of mind. The ability to understand the other person’s intentions allows individuals to attribute their actions differently and consequently adjust their behaviour towards the other person. Subsequently, their behaviours also affect the way that individuals think, creating a bidirectional relationship between cognition and emotion. Additionally, the authors also propose that attachment styles (based on anxiety and avoidance) modulate each component of the model differently.

Both models emphasize on some top-down executive control areas of the brain intervening with the affective experiential regions to direct the individual’s behavior towards maintaining positive relationships and reaping the benefits from these relationships. For example, activations in the ventromedial prefrontal cortex were also found in participants viewing images of an attachment figure while he or she is undergoing a pain-related task (Eisenberger et al., 2011). This falls in place with the discussion in the previous chapter about IWMs and the emotion regulatory effects of secure bases. Most human studies of AT in the CNS involve brain imaging techniques, the measurement of neurotransmitter production or examining genetic differences. In the PNS, specifically the autonomic nervous sub-system, psychophysiological measurements, neurotransmitters, and several behavioural measures are used.

2.2.3 IWM: Cogntive Framework

Attachment has been thought to engage two different types of components in the brain: affective and cognitive (Canterberry and Gillath, 2013; Vrticka and Vuilleumier, 2012). IWMs can be thought of as the cognitive component of attachment which capture information about interactions between the individual and the attachment target. These frameworks were suggested to be conditioned associations between the availability or responsiveness of attachment figures (or proximity) and the internal needs or external threats mediated through different regions in the brain such as amygdala, nucleus accumbens, hippocampus, and prefrontal cortex (Hofer, 2006).

IWMs are thought to engage brain areas involved in reward processing, mostly part of the dopaminergic system such as ventral tegmental area and nucleus accumbens. Brain areas involved in reward processing (i.e. part of the dopaminergic system - e.g. ventral tegmental area and nucleus accumbens) are recruited to identify and evaluate potentially beneficial and desirable attachment targets. Previous research using fMRI investigating love identified activations in reward-related regions - VTA and caudate (Aron et al., 2005; Bartels and Zeki, 2000b, 2004; Ortigue et al., 2007). Viewing images of loved ones activates similar areas (such as caudate head and nucleus accumbens) as well as other areas such as, lateral orbitofrontal cortex (OFC), amygdala, and dorsolateral prefrontal cortex (Younger et al., 2010). In terms of cultural attachment, cultural cues that prime a related cultural network could activate the same reward processing regions if the culture is preferred.

Positive feelings of attachment were posited to facilitate the release of oxytocin into motivational circuits in the brain (Campbell, 2010; Coan, 2010; Diamond, 2001; Insel, 2010). Oxytocin and vasopressin are synthesized in large quantities in the hypothalamus (Carter, 2003; Gainer, 1994). The hypothalamus was shown to coordinate activity of physiological and behavioural systems during maternal or pair bonding (Kim et al., 2011) and also to be important in social soothing during neural threat (Carter, 2003; Coan et al., 2006). The hypothalamus is also heavily involved in the regulation of ANS responses.

Memory processes provide a framework for information obtained in past interactions to be used in future ones. Memories, typically differentiated by their duration, serve various functions. Episodic memory[2] contains personal experiences while semantic memory contains factual knowledge (Tulving, 1972). Experiences between different attachment targets are encoded as memories and integrated to form a coherent IWM (Bretherton, 1990; Mikulincer and Shaver, 2004; Thompson et al., 2003).

The hippocampus plays an important role in the formation, storage, consolida-

[2]As a note, much of Bretherton's work mentioned in thesis uses generic event representation (GER). Here, episodic memory and GER are not differentiated.

tion and retrieval of internal and external states (Brasted et al., 2003; Kennedy and Shapiro, 2004). Additionally, the amygdala also plays an important role in the consolidation of positive and negative long term memory by tagging sensory experiences as significant or salient before the consolidation of long term memory. Amygdala activity has also been detected when emotionally salient information is being recalled weeks after exposure (Hamann et al., 1999). These two regions in the brain have been implicated in various attachment studies. The interaction between amygdala and locus coeruleus facilitates familiarity and reinforces filial bonds. Norepinephrine from the locus coeruleus, which neonates release in large quantities (Nakamura and Sakaguchi, 1990), has been shown to be necessary for learning in human and animals (Sullivan, 2003) as well as memory consolidation specifically (Cahill et al., 1994), especially in the amygdala (Liang et al., 1995; Kodirov, 2012). Individuals with high attachment avoidance, similar to patients with PTSD, were found to have low cell density in their hippocampus (Quirin et al., 2009) suggesting that attachment avoidance is related to selective formation of memories. Culture, when viewed as a culmination of knowledge across a group or a mental framework of norms, shared meanings and associated behaviours, necessitates a memory capacity of some sort to hold this knowledge or framework. One can argue that without memory processes, culture as we know it will cease to exist.

2.2.4 Secure Base: Emotion Regulation

The emotion regulatory aspects of attachment have been an important focus for many researchers. For example, Vrticka and Vuilleumier (2012) summarised the attachment system as an emotion regulation device while other researchers viewed it as a major stress regulatory system (Taylor et al., 2000, 2004). A common finding of studies examining SCR differences between individuals with different attachment styles is that individuals with secure attachments cope with stress better, especially when cognitively reminded or aware of their secure base (see reviews by Diamond, 2001; Gander and Buchheim, 2015). SCR measured during the Adult Attachment Interview (AAI) were higher for participants using deactivating strategies (which implied insecure attachments) compared to securely attached participants (Dozier and Kobak, 1992; Roisman et al., 2004). A similar study measuring attachment avoidance ratings correlated it negatively to the SCR of participants under stress suggesting that even repressed participants were still stressed unconsciously (Diamond et al., 2006). Neural responses of children in the presence of their mother were not affected by their levels of attachment anxiety. However, when they were alone, as compared to children with low attachment anxiety, children with high attachment anxiety showed increased activations in ventromedial prefrontal cortex and hypothalamus when presented with threatening words (O'Connor et al., 2012). In comparison to neutral scenes, showing individuals attachment-related scenes from the AAP activated areas of the brain associated with mental representations and social cognition, such as inferior parietal lobes, middle temporal gyrus, and anterior medial prefrontal cortex (Labek et al., 2016). These studies clearly show the biological effects of successful emotion regulation and threat mitigation in individuals who have access to their attachment targets and are able to leverage them as secure bases.

Various parts of the prefrontal cortex, typically associated with top-down control, have been shown to affect a wide range of processes relating to attachment. One of those processes is emotion regulation. Before discussing a heuristic model specific to emotion regulation, other studies are presented to introduce some functions in the different parts of the prefrontal cortex. The medial frontal cortex has been associated with social perception, anticipating the thoughts of others, and predicting outcomes (Amodio and Frith, 2006). The ventromedial and medial orbital areas of the prefrontal cortex have been linked to conditioning and extinction of learning, as well as automatic emotion regulation (Ellenbogen et al., 2006; Milad et al., 2005; Quirk and Beer, 2006; Sierra-Mercado et al., 2006). The dorsolateral prefrontal cortex has been associated with initiating, shifting, inhibiting and simulating the consequences of behaviour (Purves et al., 2008) and linked to several brain areas associated with sensory inputs suggesting that a role in decision making involving multiple sources of information (Krawczyk, 2002; Miller and Cohen, 2001). In contrast to the ventromedial and medial orbital regions, the dorsolateral prefrontal cortex has been linked to more effortful and deliberate emotion control (Sheppes et al., 2009; Ochsner et al., 2002). There is also support for the dorsolateral prefrontal cortex being related to language functions and working memory for representations up to ten seconds (Fuster, 1997; Ochsner et al., 2002; Kanske et al., 2010). The underdevelopment in the prefrontal cortex during infancy has led to suggestions of caregivers acting as a surrogate prefrontal cortex (Gee et al., 2013a).

In a heuristic model of emotion regulation suggested by Kohn and colleagues (Kohn et al., 2014) after a meta-analysis of relevant studies, there are three main stages in the process of emotion regulation. The amygdala and basal ganglia will signal other parts of the brain (VLPFC, anterior insula, SMA, angular gyrus, STG) upon arousal. The VLPFC will appraise the emotion and decide if there is a need for regulation. In the case that regulation is needed, the emotion regulation process takes place in the DLPFC and signals the other regions of the brain which then generate the emotional state and behavioral responses. In the case of cultural attachment, the DLPFC or other regions should react differently only towards cultural symbols and in the face of threat.

2.3 Conceptual Model

Although there is a lack of a cohesive model highlighting the attachment process, each of the components discussed in the previous section is supported by a reliable body of work. In order to make sense of processes behind cultural attachment, I will introduce a conceptual model which combines several of the individual processes involved. As the scope of the studies that follow in the later chapters is limited, the conceptual model is not expanded to include all possible biological systems in play. Instead, it only contains parts of the cognitive and affective elements of attachment. When applying features of traditional AT to these different attachment targets, it is clear that there are some features compatible but also discrepancies that need to be reconciled. Extending attachment from individuals into social groups, and incorporating the information processing view of IWMs and the effectiveness of symbolic representations of secure bases, cultural attachment was introduced and initial experiments (e.g. Hong et al., 2013,Yap et al., 2017) produced supportive results.

It is currently unknown if all the features and major tenets of AT also apply to cultural attachment. However, there are definitely similarities behind the description of attachment and cultural processes to suggest that cultural attachment shares similarities with attachment theory. The presence, availability, or activation of different secure bases in attachment (caregivers, romantic partners, cultural group, and the abstract mental representation of culture) is processed using the IWM (i.e. cognitive framework) to provide security and mitigate responses to threat. The success of the secure bases is moderated by the different factors discussed in the previous section (e.g. NFC, racial essentialism). The pursuit of identifying the presence and nature of a cognitive framework is difficult without first establishing biological differences in threat responses due to cultural attachment. The effectiveness of culture as a secure base has been examined using behavioural experiments (Hong et al., 2013) and early results are encouraging. As converging, multi-modal evidence heavily reduces the possibility of spurious findings, psychophysiological and neuroscientific methods were employed to examine if the phenomenon occurs at a more subconscious level. At the same time, different brain areas were studied to locate the components contributing to an IWM.

The conceptual model integrates ideas from three models:

1. Coan's (2016) model which describes dopamine release from reward processing regions to regions associated with emotion regulation during recall of previously salient positive experiences,

2. Kohn et al's (2014) model which refers to the emotion regulation process between affective and cognitive regions, and,

3. Vrictka & Vuillemier's (2012) model detailing cognitive and affective regions being moderated by different attachment styles.

In the full conceptual model (Figure 2.2), threatening stimuli are first processed in the affective regions of the brain and cause quick reactions from the HPA axis. Following from Kohn et al. (2014), the affective regions in the brain then allows the salience of the threat to be evaluated and if the threat is identified as salient, then emotion regulatory processes take place. To aid in the success of the emotion regulation (or in this case threat mitigation), the IWM identifies the presence of rewarding socio-cultural cues and stimuli which results in dopamine release from reward processing regions to different parts of the prefrontal cortex involved in emotion regulation. The DLPFC (and other regions involved in emotion regulation) then signal the success (or failure) of the threat mitigation to the affective regions which then pass on the signal to the hypothalamus, motor regions, and other regions required to react to the threat. A behavioral response is then made.

The conceptual model proposed highlights the magnitude of the entire body of research which leads to more questions than answers. At this stage, it would be prudent to narrow the focus of the thesis. The aim of this thesis was to initiate research into the novel area of cultural attachment by first identifying if cultural attachment can mitigate subconscious biological responses to threats and following that by examining if the brain regions identified in the model are involved in this process. Specifically, the research questions that this thesis attempts to answer are:

1. Does the presence of cultural stimuli from an individual's primary culture reduce the biological responses to threat?
2. Are brain regions responsible for a) threat detection, b) threat evaluation, c) emotion regulation, d) reward processing, e) memory recall, f) HPA axis activity, and g) other possible components of attachment, activated in the presence of threat and cultural stimuli?
3. Which of the moderators identified in 2.1.5 predict differences in the threat mitigation process?

In order to answer the research questions, two experimental studies were set up to elicit threat responses from participants before attempting to comfort them with different secure bases. During this process, measurements of the participant's SCR and BOLD responses were taken. The experimental methods, stimuli, and statistical analyses used in these studies are discussed in greater detail in the next chapter.

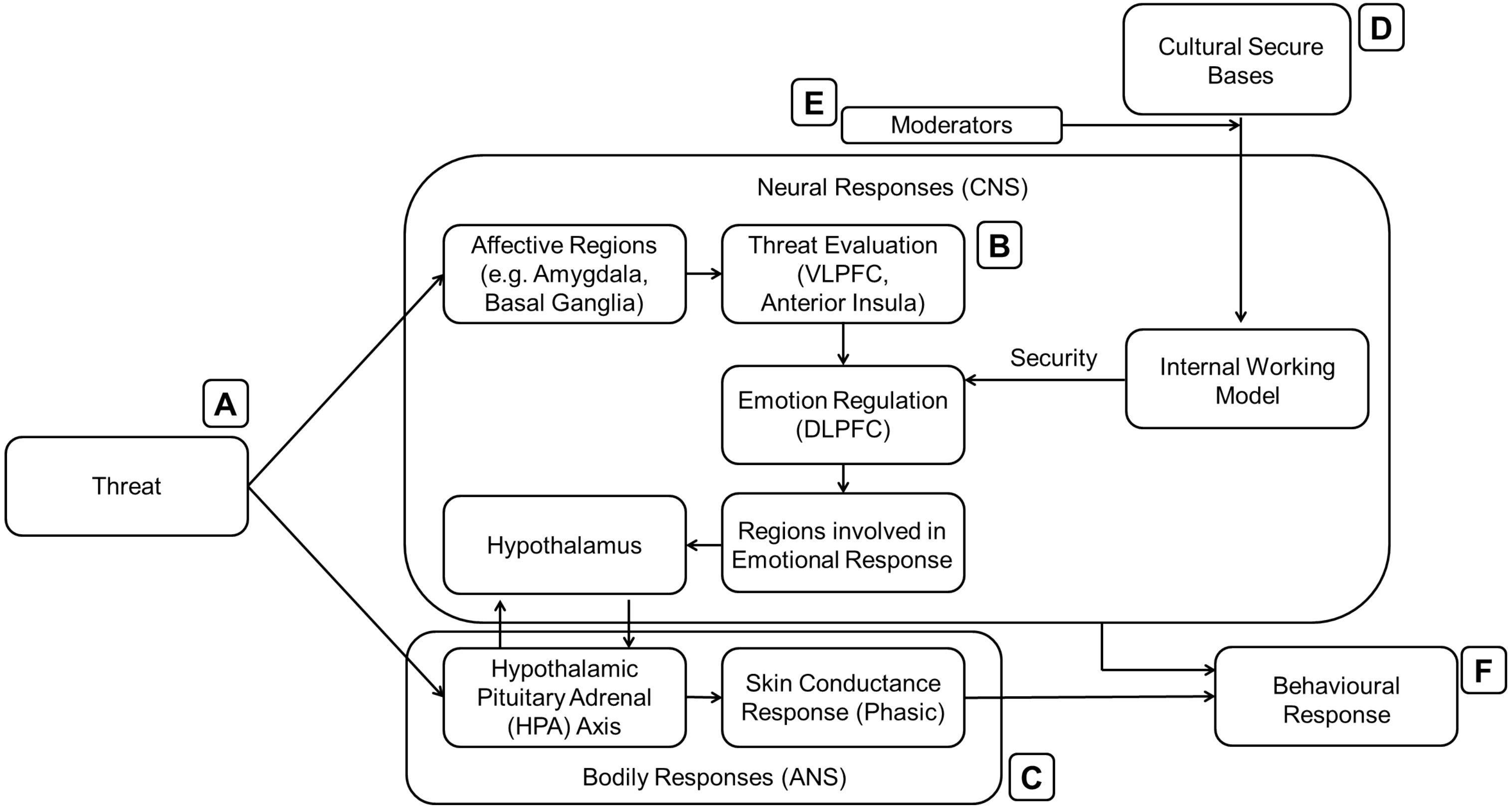

Figure 2.2: Full conceptual model. A) Presence of threat leads to responses in the affective regions of the brain and ANS. B) This is followed by threat evaluation and, if necessary, emotion regulation. The affective regions signal the threat evaluation regions which in turn signal emotion regulation regions if the threats are salient. If emotion regulation is successful, signals are fed to back to affective regions and to other regions involved in emotional responses (e.g. motor, hypothalamus). C) The HPA controls ANS responses which are typically subconscious and automatic responses to the environment. If emotion regulation is unsuccessful, SCR prepare the body for further responses. D) Presence and availability of secure bases or the activation of the cognitive representation of secure bases is processed in the IWM before being passed on to aid emotion regulation. E) External factors moderate the strength of the secure bases. F) After the brain and body has assessed and processed the threat, a behavioural response is made if one is necessary.

Chapter 3

Methods

In order to answer the research questions posed in the previous chapter, two experimental studies will be conducted. This chapter provides a brief background on the principles used in these studies and also highlights the novel contributions of the adapted version of the paradigm used in this thesis. It also covers the techniques behind the collection of SCR, fMRI, and behavioural response data as well as the statistical analysis of these methods. Additionally, the stimuli used in this thesis and the pre-studies used to validate them are also included. Following from the conceptual model, the biological responses of individuals are measured when they are both under threat and exposed to cultural secure bases. In order to execute that in an experiment, a source of cultural stimuli and a source of threat are needed. As mentioned in Chapter 2, cultural priming is a reliable way of activating the memory network associated with one's home culture. Cultural priming should also activate the IWM of that individual. As for threat, the experimental paradigm used in this thesis is adapted from affective priming paradigms previously used in studying adult and cultural attachment (Hong et al., 2013; Mikulincer et al., 2001b). In those studies, the paradigm was used to study adult partners (Mikulincer et al., 2001) and the home culture icons of expatriates (Hong et al., 2013), and provide

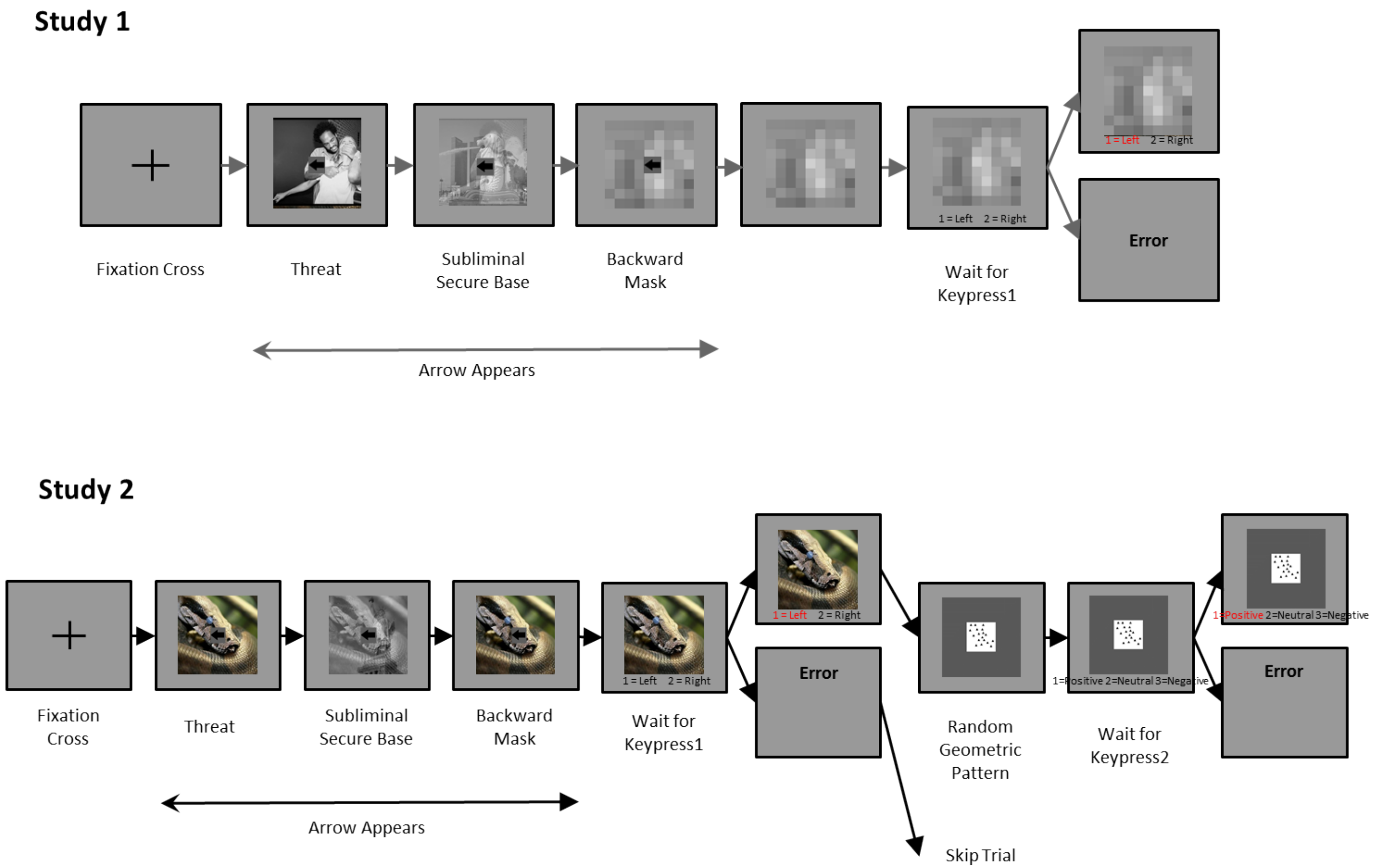

Figure 3.1: Examples of 1 trial in each study. In both studies, a threatening image is presented before a secure base is subliminally presented. Participants had to indicate the direction of the overlaid arrow in both studies. In study 2, participants also rated a random geometric pattern in terms of likeability.

evidence that they were effective in eliciting and mitigating threat. The priming paradigm is adopted as it has been shown to activate cognitive frameworks reliably. In terms of biological responses, the two studies measure responses from the ANS and CNS respectively using SCR (Ch 3.12, Study 1) and fMRI (Ch 3.13, Study 2). Since emotional states have been previously shown to affect reaction times of individuals when performing cognitive tasks, reaction time measures are also used as a proxy for possible differences in behaviour. Another behavioral response measured is the likeability rating of an unrelated randomly generated geometric pattern presented after the threat-secure base paradigm. Following the principles of affective transfer, the likeability rating reflects the emotional state of the participant during the paradigm. Lastly, several questionnaires were also administered to measure possible individual differences in the psychological constructs acting as moderators or confounds (from chapter 2). Figure 3.1 shows examples of trials found in Study 1 and 2. The paradigm involves threatening the participant before providing the participant with a cultural (secure base) stimulus. Cultural attachment predicts that cultural symbols would mitigate some of the threat experienced by the participant. In this thesis, this mitigation is measured using differences in experimental probes (such as likeability ratings or reaction times) and nervous system responses (skin conductance and brain responses) across experimental conditions.

3.1 Affective Priming

Affective priming occurs when stimuli inducing emotional responses and bias judgment of subsequent stimuli (Murphy and Zajonc, 1993). It relies on the affective primacy hypothesis which suggested that affective reactions can be elicited with minimal stimulus input (Zajonc, 1980). Before this, emotions were thought to require prior cognitive mediation and to be effortful (Lazarus, 1991). Many experiments have since taken advantage of affective priming to elicit and measure emotional responses. An example is the reduction in time taken to identify the emotion of a target when the prime and target were congruent in their emotions (Fazio et al., 1986). Subsequently, the rated valence of otherwise neutral targets was shown to follow those of the primes before them (Payne et al., 2005).

A phenomenon that can be confused with affective priming is evaluative conditioning. Evaluative conditioning, which is a form of classical conditioning, shows that the judgment and evaluation of an object can be changed if it is repeatedly paired with another affectively charged object (Hofmann et al., 2010). However, unlike affective priming, evaluative conditioning takes place over a longer period of time and typically also has longer lasting effects. The pairing of commodities with other desirable people or products in branding and marketing campaigns can be thought of as evaluative conditioning. In contrast, affective priming is easier to achieve and its effects are more short-lived. The diffusion of the affect from a stimulus to another has been shown to take place even if either or both stimuli were presented subliminally (5ms; Monahan et al., 2000).

3.2 Subliminal Priming

Subliminal priming has been a popular method to study topics in human cognition where active conscious processing will otherwise bias responses. In order to avoid the cultural symbols actively biasing the responses of individuals when they are consciously aware of them, the secure base stimuli in this thesis were presented subliminally (23-30ms). In one of the first studies using subliminal priming, researchers subliminally presented (100ms) words related to hostility or kindness to different experimental groups and found the attitudes of members of each group to be influenced by the nature of the word presented to them (Bargh and Pietromonaco, 1982). Later experiments confirmed that the subliminal stimuli were not processed at a conscious level by participants. Participants correctly identified objects presented subliminally (47ms) only 13.5% of the time in a 4 alternate forced-choice task (Bar and Biederman, 1998). Despite the lack of conscious processing, a meta-analysis of priming studies suggested that subliminal primes can be processed semantically (Van den Bussche et al., 2009) and that subliminal primes were more evoking than supraliminal ones (DeCoster and Claypool, 2004). More recently, the subliminal presentation of fearful stimulus after a positive stimulus in a fear-conditioning experiment enhanced positive associations made with that stimulus (Beckes et al., 2010). Additionally, another experiment showed that cortisol levels increased when participants were subliminally primed with fearful faces (Hnsel and Knel, 2013)

Recent developments suggest that in order to for the stimulus to be subliminal, presentation times should not exceed 50ms and are recommended to be lower than 20ms (Williams et al., 2004, 2006). Many recent studies follow this time window (e.g. Liddell et al., 2005; Posten et al., 2014; Matsumoto and Kakigi, 2014; Khalid et al., 2013). Another important aspect of subliminal priming is the presence, type and presentation length of forward and backward masks. Subliminal priming studies typically include a backward mask but a forward mask is used at the researcher's discretion. The forward mask, which comes before the prime, serves as a cue to focus the participant's attention and according to some researchers also plays a part in restricting conscious visual processing (Bar and Biederman, 1998; Harris et al., 2011; Yu et al., 2014). The backward mask, which comes after the prime, has been shown to restrict conscious processing of the prime and is important in ensuring that the prime is presented subliminally (Eimer and Schlaghecken, 1998; Carlson et al., 2009).

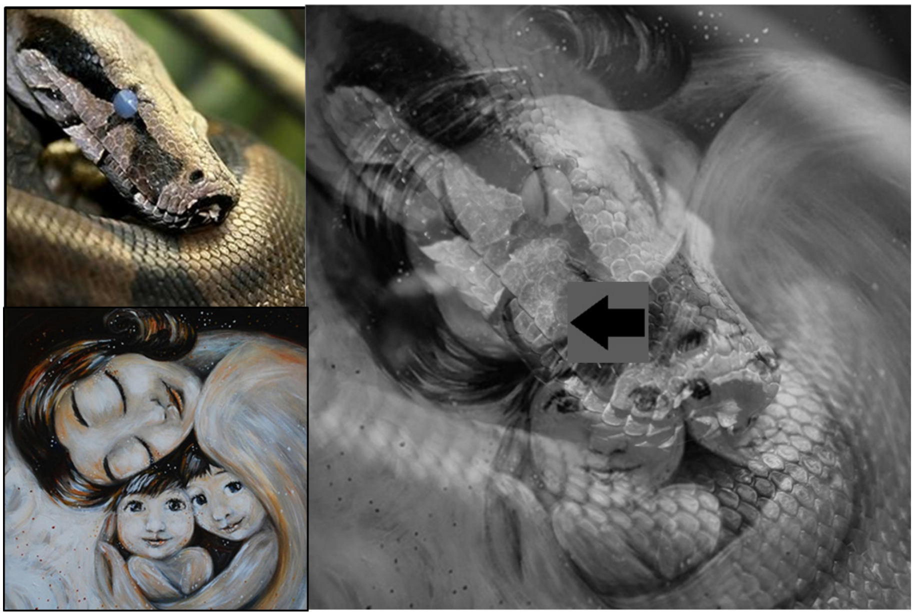

Figure 3.2: 1) Example of Threat Image 2) Example of Maternal Image 3) Example of overlaid image used as subliminal stimulus with arrow in the middle.

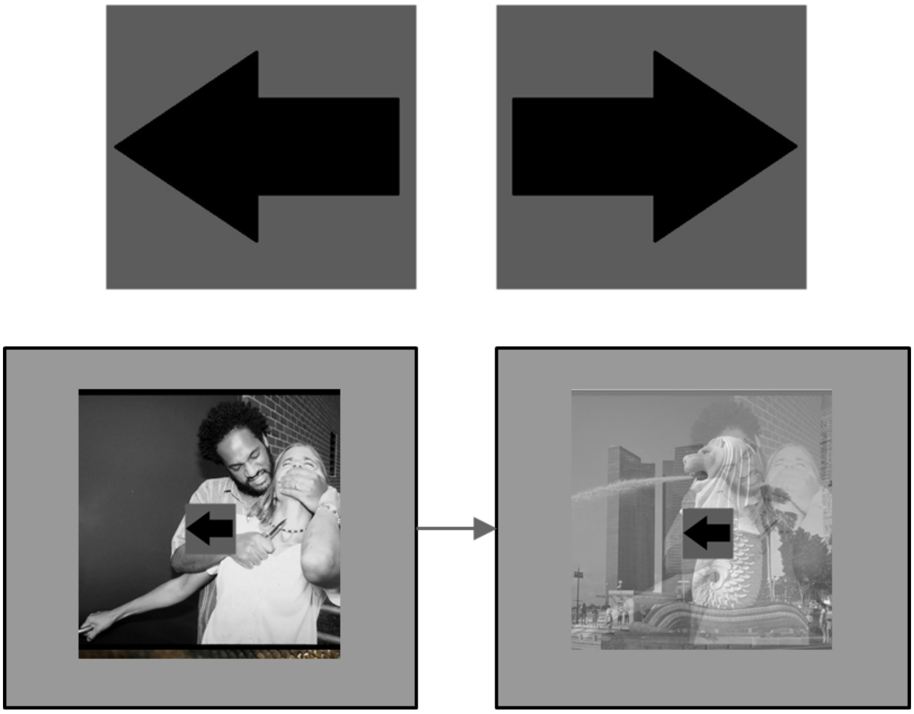

Figure 3.3: Example of arrows overlaid on threat and subliminal images.

Features and presentation times of the forward and backward masks also need to be focused on. For example, the valence of mask used (whether neutral or positive) affected both the perception of the prime as well as the reaction times of participants in identifying target images (Jakowski and Przekoracka-Krawczyk, 2005). In this thesis, the valence of the images used is a factor in the experimental design so corresponding differences should be observed in the results. Another important feature is the inter-stimulus interval (ISI), which is the amount of the time between the presentation of different stimulus in the same trial, of the masks and prime. Previous research has shown that reaction times of motor responses were lengthened when the ISI was increased from 0ms to 100ms (Schlaghecken and Eimer, 2002). In the studies which form part of this thesis, the ISI is kept to 0ms to ensure faster responses that rely less on deliberate cognitive processes and also to maximise the success of the subliminal priming. Lastly, simultaneous masking, where the mask and prime stimuli (sometimes overlapping) appear together (Breitmeyer and men, 2006), was used to further reduce the saliency of the target. Each subliminal secure base image was overlaid with the threat/non-threat mask image that appeared before it with both images set at 50% transparency (Figure 3.2). Each study in this thesis uses a slightly different masking setup to cater to different environmental conditions in each modality.

3.3 Secure Base Stimuli

Secure base stimuli used here are classified into four groups: Home, Host, Maternal, and Control (see Figure 3.4, pg43). Home culture stimuli refer to cultural icons from the place where the participant grew up in. Host culture stimuli refer to cultural icons of the place that the participant is currently residing in. Similar to previous studies (Mikulincer and Shaver, 2007b), maternal stimuli refer to

Figure 3.4: Example of secure base images. From left to right: Singaporean, Chinese, American, Maternal, Control

representations of the maternal-child dyad usually containing images of mothers holding their children. Control stimuli were animated images of treasure chests used to depict general wealth as security explain also that they are commonly used. Due to the different nationalities of the samples used in each study, the corresponding home and host cultural stimuli are different in each study. In study 1, Singaporean cultural stimuli were used as home cultural stimuli. In study 2, for Chinese participants, Chinese cultural stimuli were used as home cultural stimuli and American cultural icons were used as host cultural stimuli; whereas for American participants, American cultural stimuli were used as home cultural stimuli while Chinese cultural stimuli were used as foreign cultural stimuli. Maternal images were added in Study 2 to make exploratory comparisons between cultural and maternal attachment. The control images were the same in both studies.

The cultural images represented 3 countries: USA, China, and Singapore. American images (n = 10; Cheon et al., 2016) and control images (n = 5; Hong et al., 2013) were obtained from previous studies. Chinese and Singaporean images (n = 10 each) were sourced from the Internet to match contents of the American images (i.e. matching a landmark with another landmark). Maternal images were also sourced from the Internet. Other than control images, ten images from each category were selected for use in the following pre-studies where a set of criteria (details below) were implemented to select the 5 most appropriate images.

3.4 Supraliminal Threat

Unlike previous studies (Mikulincer et al., 2001b; Hong et al., 2013), the threat images in this thesis were presented supraliminally (283 ms) and function as the forward and backward masks of the secure base images. One of the primary reasons for this is that the presentation of consecutive subliminal stimuli (i.e. secure followed by threatening images) would introduce complexity to later analysis owing to them being almost temporally impossible to separate. Using supraliminal threats lead to the concern that conscious defensive mechanisms would cause the priming to backfire and participants would display the opposite effect (e.g. terror management theory; Beckes et al., 2010, 2013). However, other studies provided evidence that brain regions processing threat (such as the amygdala) were still activated regardless of the format of stimuli (Liddell et al., 2005). The threats used here were mainly threats to the mortality of the participant to incite a defensive response (Jonas et al., 2014). Due to the nature of uncertainty reduction in culture, threats to the mortality were deemed as appropriate due to them increasing the uncertainty surrounding the survival of the individual.

Stimuli used in the studies in this thesis are classified into 2 categories (threatening or non-threatening). All of the threatening images and some non-threatening images were selected from the IAPS database (Lang et al., 1997, 2008). Due to a lack of non-threatening images, more images which matched the content type (e.g. a person holding a knife is matched to a person holding a mug) and colour schemes of the threatening images were sourced from the Internet. The threatening images used were of people pointing weapons (knives or guns) towards another person or the viewer and ferocious animals (snakes, spiders, dogs) poised to attack the viewer. Non-threatening images include images of daily mundane scenes with or without humans in them. The pre-studies below discuss the process in which these images were rated and selected for use in the studies.

3.5 Pre-Studies: Image Validation

Two pre-studies were conducted to select appropriate stimuli for the experiments. Appropriate stimuli were those that correctly represent their respective categories (e.g. American, Chinese, Singaporean). As mentioned above, images used in the pre-studies were obtained from different sources. However, all images were scaled to a similar dimension before being presented to the participants. Pre-study 1 conducted in Beijing, China was used to collect data regarding appropriate images for all except the Singaporean category. Pre-study 2 conducted in Singapore was used to collect data regarding the Singaporean category. Figure 3.5 highlights the ratings obtained in each pre-study and the study that the images were eventually used in. Most of the images from both studies were obtained in pre-study 1. Only the Singaporean images were obtained in pre-study 2. The threatening, non-threatening, and control images were used in both studies 1 and 2. The results from both studies suggest that the stimuli selected were suitably representative of their categories. Further ratings were obtained from participants in the main studies to reinforce this.

3.5.1 Pre Study 1

Participants: 31 Chinese nationals (M_{age} = 31.5, sd = 8.5; 10 females) in Beijing, China were recruited using an online platform (Sojump) to rate images in an online questionnaire (administered using the Qualtrics platform). The questionnaire was administered in Mandarin and participants were paid RMB25.5 (through Sojump) for their participation. This study was approved by the institutional review board of Beijing Normal University.

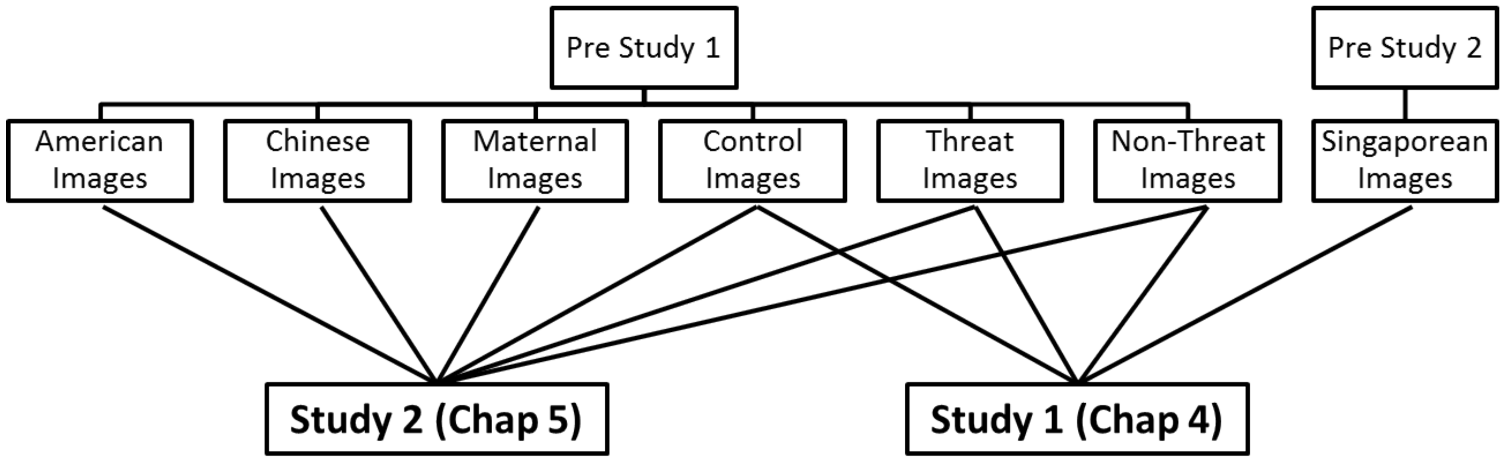

Figure 3.5: Link between ratings obtained during pre-studies and the studies where the images were eventually used.

Method: Participants were asked to rate two groups of images (23 threat/non-threat and 45 secure base) based on the following dimensions. Threat/non-threat images included two categories (Threat & Non-Threat). These images were rated on their 1) threat level, and 2) familiarity. Secure base images included four categories (American, Chinese, Maternal, and Control). These images were rated on how 1) American, 2) Chinese, 3) attractive to the participant, and 4) connected to the participant they were. Images were displayed in two separate blocks where threat/non-threat images were in one block and secure base images were in the other. The order of the blocks was randomized across participants. The order of the images was randomized within each block for each participant.

Results: Five most appropriate images were selected for each group for use in Study 2. Descriptive statistics of the images are shown in Table 3.1. Threat images (M = 1.97, sd = 0.16) were rated as less attractive than non-threat images (M = 3.18, sd = 0.50, $t(60)$ = 12.833, p <0.01). American images (M = 4.72, sd = 0.15) were rated as more American than Chinese (M = 1.32, sd = 0.13, $t(60)$ = 95.57, p <0.01), maternal (M = 3.14, sd = 0.49, $t(60)$ = 17.03, p <0.01), and control images (M = 3.79, sd = 0.13, $t(60)$ = 26.22, p <0.01). American images were not rated as representative of Chinese images (M = 1.48, sd = 0.17, $t(60)$ = 80.12, p <0.01). Chinese images (M = 4.84, sd = 0.04) were rated as more Chinese than American (M = 1.48, sd = 0.17, $t(60)$ = 109.36, p <0.01), maternal (M = 3.64, sd = 0.45, $t(60)$ = 14.84, p <0.01), and control images (M = 3.24, sd = 0.25, $t(60)$ = 35.81, p <0.01). Chinese images were also not rated as representative of American culture (M = 1.32, sd = 0.13, $t(60)$ = 146.98, p <0.01). This suggests that the images used were suitably representative for their respective category.

Table 3.1: Stimuli ratings from pre-study 1

	American	Chinese	Attractive	Connected
American Images	4.723	1.484	2.284	3.194
	(.152)	(.166)	(.234)	(.342)
Chinese Images	1.323	4.838	3.800	4.155
	(.127)	(.040)	(.198)	(.312)
Maternal Images	3.142	3.639	3.361	3.774
	(.494)	(.448)	(.252)	(.189)
Control Images	3.787	3.241	3.090	3.613
	(.128)	(.245)	(.100)	(.123)
Threat Images	3.632	2.261	1.971	2.232
	(.136)	(.224)	(.156)	(.156)
Non-Threat Images	3.806	3.058	3.177	3.055
	(.495)	(.398)	(.501)	(.359)

Note. Standard deviations are in parentheses. Ratings range from 1 to 5.

Table 3.2: Stimuli ratings from pre-study 2

	American	Chinese	Singaporean	Attractive	Connected
Singaporean Images	1.924	2.609	4.498	3.076	2.446

Note. Standard deviations are in parentheses. Ratings range from 1 to 5.

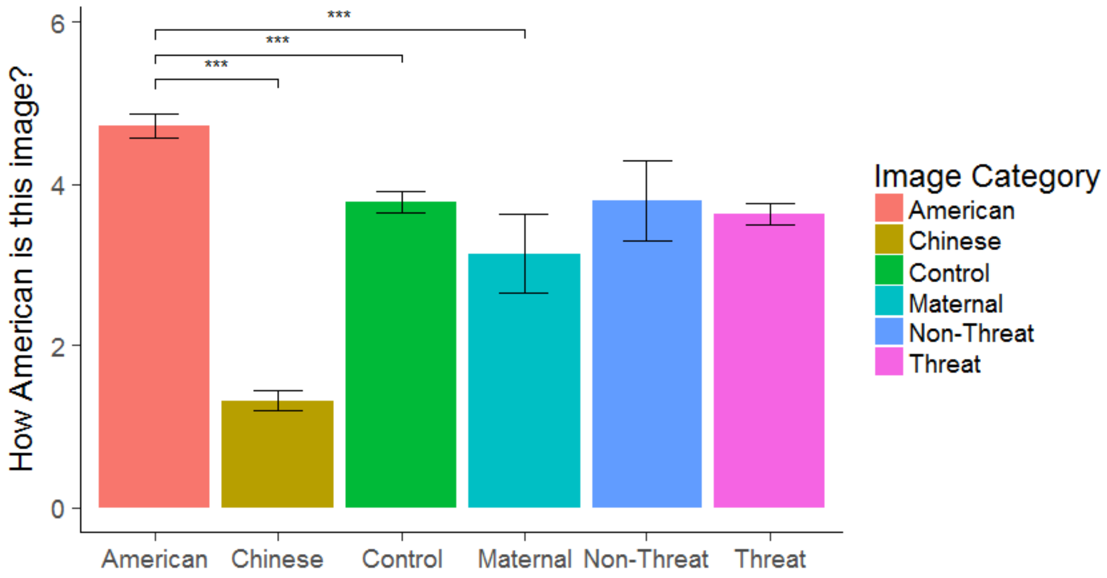

Figure 3.6: Comparison of image ratings from different categories on ”How American is this image?”. Error bars indicate +/- 1 SD. *p<0.1; **p<0.05; ***p<0.01

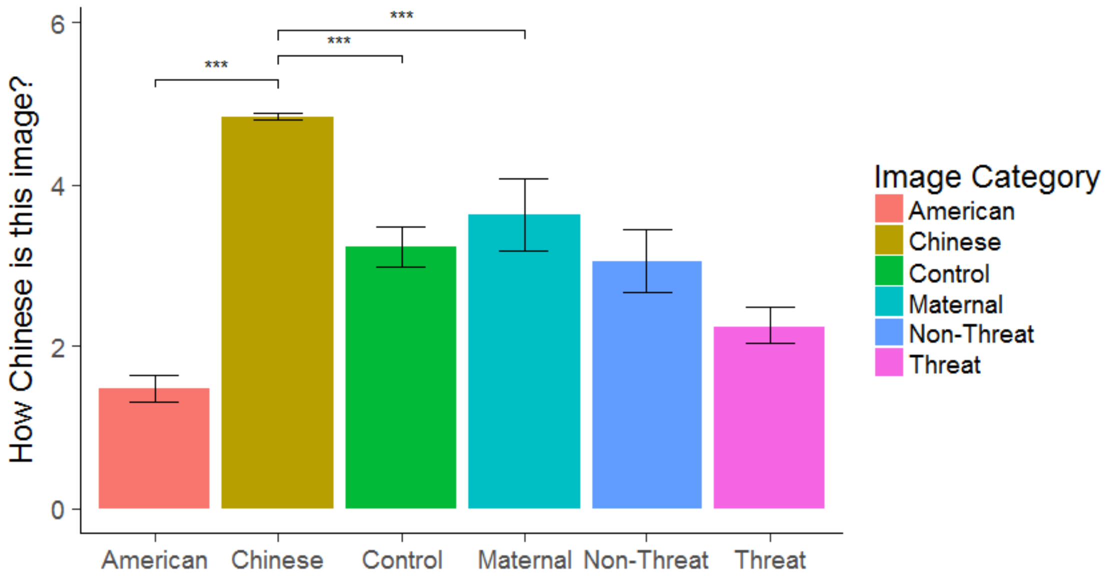

Figure 3.7: Comparison of image ratings from different categories on ”How Chinese is this image?”. Error bars indicate +/- 1 SD. *p<0.1; **p<0.05; ***p<0.01

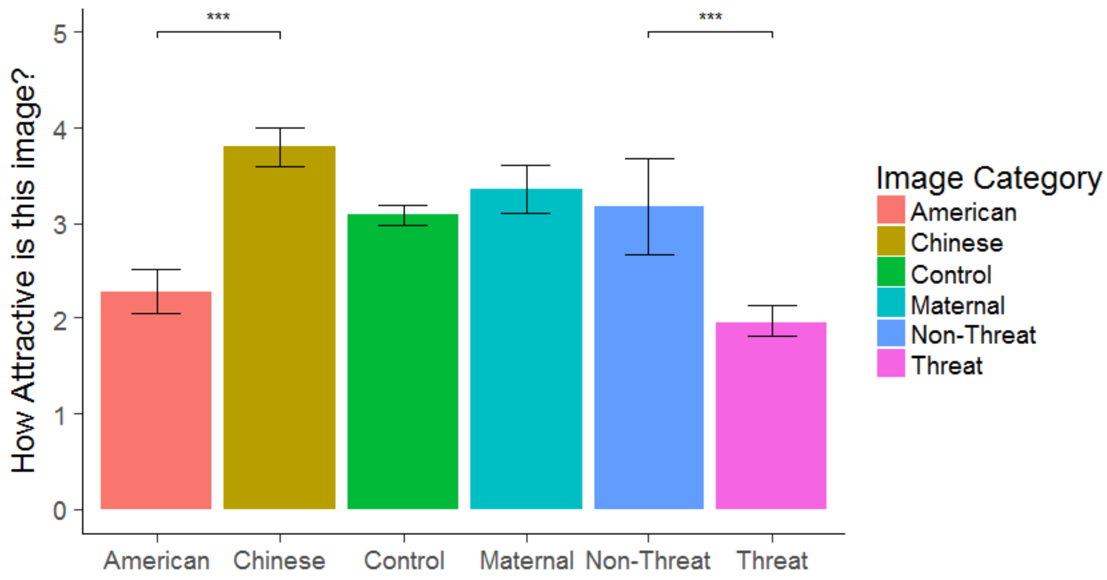

Figure 3.8: Comparison of image ratings from different categories on ”How Attractive is this image?”. Error bars indicate +/- 1 SD. *p<0.1; **p<0.05; ***p<0.01

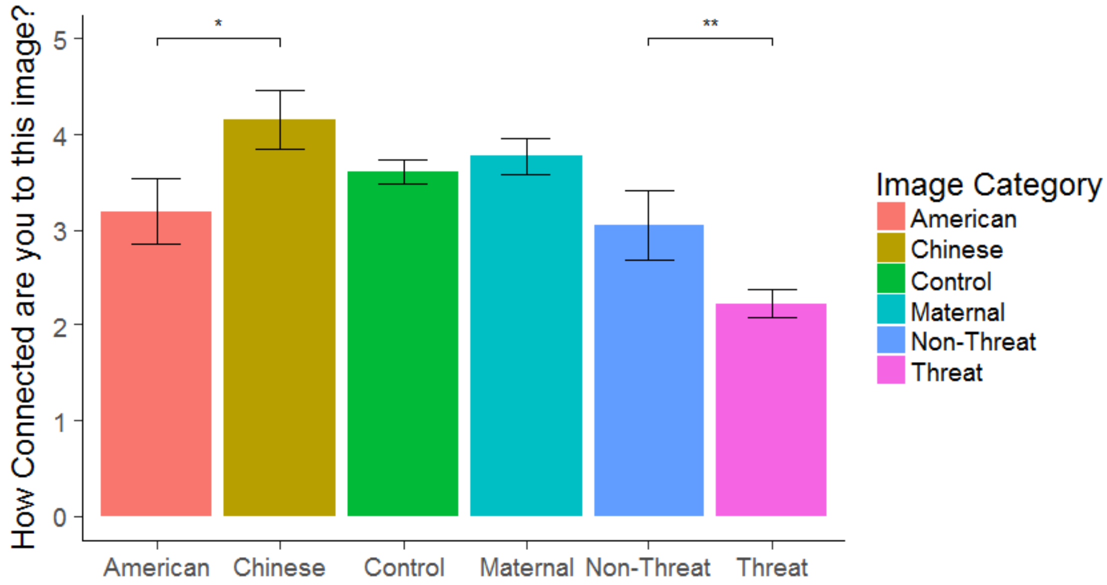

Figure 3.9: Comparison of image ratings from different categories on ”How Connected are you to this image?”. Error bars indicate +/- 1 SD. *p<0.1; **p<0.05; ***p<0.01

3.5.2 Pre Study 2

Participants: 24 students from Singapore (M_{age} = 22.1, sd = 2.6; 18 females) were recruited using the NTU's online recruitment system to rate images in a laboratory setting (administered using the Qualtrics platform). Participants were paid SGD5 for their participation. This study was approved by the institutional review board of Nanyang Technological University.

Method: Participants were asked to rate a set of images representing Singaporean culture based on the following questions: How 1) American, 2) Chinese, 3) attractive to the participant, and 4) connected to the participant they were, and 5) Singaporean are these images? Images were presented in a randomized order.

Results: Four appropriate images were selected as representative of Singaporean culture. Table 3.2 contains the descriptive statistics of these images. These images selected were rated as representative of Singaporean culture (M = 4.50, sd = 0.71) and not as representative of American (M = 1.92, sd = 0.73; $t(44)$ = 12.06, $p < 0.01$) or Chinese (M = 2.61, sd = 1.06, $t(44)$ = 7.10, $p < 0.01$) culture. Images selected were also neutral in attractiveness (M = 3.08, sd = 0.47).

3.6 Adaptations to experimental paradigm

One main difference between the paradigm used in this thesis and that used in other studies is the type of stimuli used. In prior studies, participants were threatened by being exposed to threatening words and comforted either by comforting words (Mikulincer et al., 2001b) or images (Hong et al., 2013). In this thesis, participants are threatened by being exposed to threatening images and comforted by secure base images. The primary decision to use only images is to ensure consistency across formats of stimuli used as it was revealed in a meta-analysis that differences in formats of stimuli resulted in widely varied effect sizes (Van den Bussche et al., 2009). On top of that, the same study also suggested that experiments using symbols and pictures yield larger effect sizes than those using words. This is in line with an earlier meta-analysis suggesting that direct priming methods such as reading paragraphs or recalling incidents are more effective than indirect ones such as word unscrambling tasks (DeCoster and Claypool, 2004). Additionally, this allows for the threat/non-threat images to act as forward and backward masks for the secure base image (refer below for subliminal priming).

Previous research has suggested that humans are sensitive to different colours. In an EEG study of facial expression perception, researchers found that unconscious processing of the same faces with different hues was reflected in N170 (Minami et al., 2015). The V4-complex region has also been identified in the brain as the part of the brain that is sensitive to colours (Bartels and Zeki, 2000a). In order to make images as consistent as possible and to remove possible noise in the biological data due to the different colours in the images, grayscale versions were used instead of the original images.

Finally, different presentation times of the masks and subliminal stimulus were used in each study. This was done to maximize the signal-to-noise ratio of each modality while reducing the fatigue levels of participants. For example, SCR occur over a longer period of time (in the order of seconds) so the inter-trial interval for Study 1 is longer than in Study 2 (4.5s to 2s). SCR also reduce as the participant habituates so the length of the experiment is limited to account for that. This shortcoming also resulted in the removal of the affective transfer task in Study 1. Minor changes to the presentation time of the subliminal stimulus were made to cater to equipment limitations (mostly refresh rate of computer monitors) in the different setups.

3.7 Attention Tracking Mechanism : Arrow

A feature of the paradigm that is entirely new is the appearance of a small arrow during the subliminal priming portion. Due to the rapid nature of subliminal priming, ensuring that the participant is paying attention is paramount. Additionally, previous research suggests that the effectiveness of affective transfer increases when there is less causal attribution of the emotions (Oikawa et al., 2011). In addition to making sure participants pay attention, the additional task reduces their cognitive ability to deliberately attribute their emotions to the images. To achieve that, a small black arrow on a grey background appears in the middle of the supraliminal and subliminal images shown (as shown in Figure 3.3, pg41). During each trial, the arrow randomly points towards the left or right. After the backward mask, two options (“Left” and “Right”) appear on the screen. Participants were instructed to respond as quickly as possible to the question indicating the direction that the arrow pointed to. Trials in which participants fail to indicate an option in time or correctly were excluded from further analysis.

3.8 Affective Transfer Task

In Study 2, an additional experimental probe - the Affective Transfer task (Mikulincer et al., 2001b; Hong et al., 2013) - was used. After participants stated the direction of the arrow, an image containing randomly placed geometric patterns appeared on the screen (see Figure 3.10, pg55). Subsequently, three options appeared on the screen (“Positive”, “Neutral”, “Negative”). Participants were instructed to rate the likeability of the pattern according to this 3-point scale. Although using a scale with more options is likely to capture more variance, physical limitations restrict the feasibility of that choice. As participants provided their responses via a button

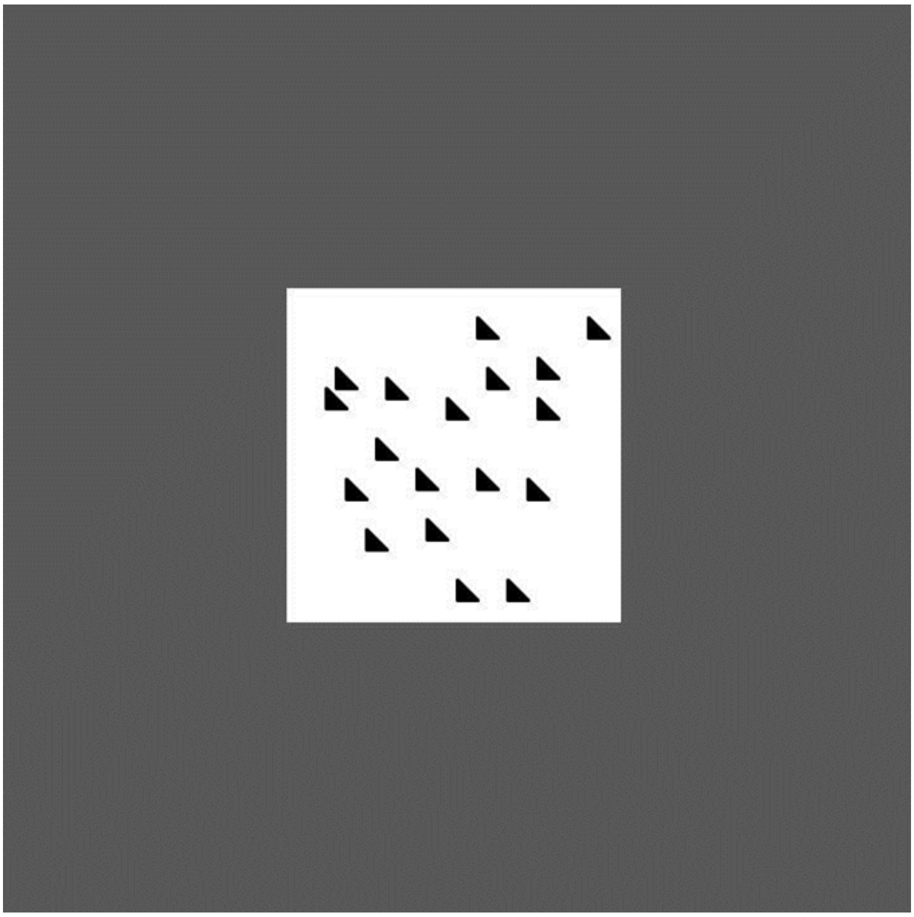

Figure 3.10: Example of random geometric pattern used.

box while in the fMRI scanner, a 3-point scale was selected to reduce possible erroneous and unintentional button presses. Geometric patterns were chosen randomly from a set (n = 130; 13 groups of 10 images each with each group having a different base shape such as triangles or circles) which was previously validated to be of neutral valence (Hong et al., 2013). Following from affective priming principles, threatening stimulus and secure base stimulus are hypothesized to influence the likeability of the otherwise neutral geometric patterns. If the threat experienced is not mitigated, the likability of the geometric patterns would be negative and vice versa if the threat is successfully mitigated.

3.9 Reaction Time (Arrow direction and Likeability responses)

Another experimental probe used was the reaction time of participants to indicate the direction of the arrow and the likeability rating of the geometric pattern. Reaction time measures are commonly used to capture subtle biases that are often subconscious to the participant (Kosinski, 2008). In fact, it has been recommended together with other implicit measures for use in capturing unconscious parts of attachment (Pietromonaco and Barrett, 2000). Reaction time in attachment studies has been typically used in implicit association tasks. For example, insecurely-attached individuals have been found to reject secure sentences (consisting of content relating to secure attachment) more quickly than securely-attached individuals (Wichmann et al., 2016). However, it has also been measured in responses towards threats. For example, Cloitre and colleagues (Cloitre et al., 1992) found that the reaction time of socially anxious participants is slower than normal people in the presence of threat. In this thesis, reaction time measures could shed light on the mechanisms of threat mitigation of secure bases.

3.10 Statistical Analysis: Reaction Time

The pre-processing of reaction time data is important due to several features of reaction time. Reaction time data often violates normality with a positive skew, has several extreme outliers, and have temporal dependencies on the number of previous trials (Whelan, 2008; Baayen and Milin, 2010). The reaction time of participants who are motivated to react quickly typically cluster at a certain time but some of their responses will be slower (usually by 1 or 2 standard deviations) due to many reasons. Compounding with that is the occurrence of extreme outliers, mostly due to participants losing focus or feeling fatigued. This results in a positively skewed reaction time distribution for each individual that typically fail normality tests (such as Shapiro tests). Consequently, using ANOVAs to handle RT differences has also been frowned upon, with more robust methods (such as including the median as the central tendency measure) being suggested (Whelan, 2008). Other methods to handle these problems are to perform a log or inverse transformation to “squeeze” the data or to use generalised linear mixed models (GLMMs; Lo and Andrews, 2015). However, before applying statistical methods, many scholars advocate the removal of outlier data that defy biophysical limitations of the task ($<$100ms, Luce, 1986; Carlson and Reinke, 2008; Fox, 2002; Carlson et al., 2009 or $<$5ms, Baayen and Milin, 2010 or exceeds a ceiling for the task ($>$5s, Baayen and Milin, 2010). Temporal dependency is another issue and refers to the possible effects of fatigue or learning on the reaction time of later trials. In difficult tasks, as participants undertake more trials, they are more likely to be cognitively depleted and fatigued (Welford, 1968, 1980; c.f. Kosinski, 2013). Yet, physical depletion such as muscular fatigue has been shown to have limited effect on reaction time (Kroll, 1973; c.f. Kosinski, 2013). Trial order or time of stimuli presentation is usually included as a control variable and has been shown in previous studies to have a significant effect on reaction time Baayen and Milin, 2010. The removal of their effects is said

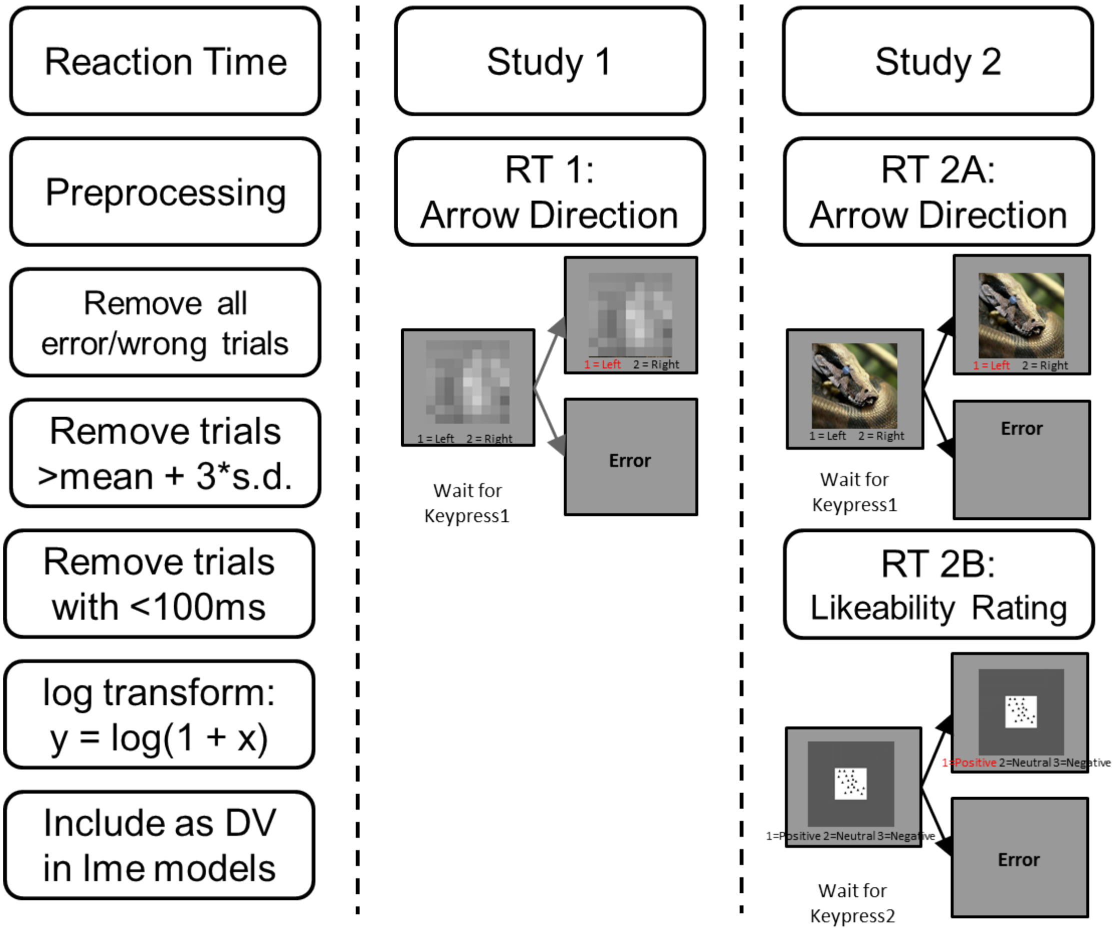

Figure 3.11: Preprocessing procedures for reaction time measures.

to allow for more precise estimations of the contributions of the predictors (e.g. Kuperman et al., 2010; Tabak et al., 2010). The preprocessing measures for reaction time measures and the respective reaction times measured in this thesis are summarised in Figure 3.11. In both studies 1 and 2, the time taken for participants to indicate the direction of the arrow is measured. In study 2, there is an additional measurement for the time taken for the participant to indicate his/her likeability rating of the random geometric pattern. Before these reaction times are analysed in the linear mixed effects models, there are a number of steps taken to ensure the quality of the data. First, trials where the participant did not answer in time or made a mistake were removed (participants can only make mistakes for the arrow question). After that, trials with reaction times which are at least three standard deviations longer than the mean response were removed. Following that, the reaction time measures were log transformed and included as dependent variables in the linear mixed effects models.

3.11 Self-Reported Questionnaires

In addition to experimental probes, several questionnaires were administered to measure various individual differences. Many of the constructs measured are derived from previous related studies of attachment and cultural attachment. Some of the constructs measured are commonly associated with cultural differences across US and Asia. The scales mentioned below were not always used in all studies. Details of scales used can be found in the sections for the respective studies. All scales are also included in the appendix. All questionnaires were hosted on an online survey platform (Qualtrics, Provo, UT).

3.11.1 Cultural Attachment

Two measures of cultural attachment were used in this thesis. As cultural attachment is fairly new, the scales used are derived from previous attachment scales. These scales are aimed at meaningfully breaking down cultural attachment. In this thesis, these scales are used to examine if there are important sub-dimensions and categories that are related to the nervous system response. For the purposes of clarity, the scales will be referred to as Cultural Attachment Categorical Scale and Cultural Attachment Dimensional Scale. Both scales measure one's attitudes towards a particular culture. In this case, home cultural attachment is always collected and host cultural attachment is collected as and when appropriate. The Cultural Attachment Categorical Scale (Svetlana et al., 2016) is based on two previous scales (Hazan and Shaver, 1987; Bartholomew and Horowitz, 1991) and contains four categories: security (belonging), insignificance, boundarylessness and sacredness. The scale focuses on the sub-dimensions of the relationship between the person and the culture. Each sub-dimension contains three questions and is measured on a 1 to 5 Likert's scale. The security sub-dimension measures if the individual has a secure relationship with that culture, similar to other types of secure attachment. A sample item is "My Home country cares for my family and me". The insignificance sub-dimension measures how insignificant the person feels with respects to that culture. A sample item is "I feel my problem and me are too small, too insignificant, for my Home country". The boundarylessness sub-dimension measures how restricted the person feels with the cultural norms that are in place. A sample item is "I feel at home at any place where my friends and family are, and it doesn't matter to me which country I am in". The sacredness sub-dimension measures how sacred is the culture in the eyes of the individual. A sample item is "I believe people should fully accept everything about their Home country". The Cultural Attachment Dimensional Scale (Hong et al., 2013) is based on Brennan et al.'s (1998) factor analysis of Bartholomew (1990) which resulted in two dimensional scale of anxiety and avoidance. There are ten questions for each subscale and each question is measured on a 1 to 5 Likert's scale. Participants are deemed to have a secure attachment to that culture if their score for both subscales are low.

3.11.2 Cultural Identifications

Cultural identity is the self-perception of belonging to a group. Previous studies investigating more than one culture (e.g. Indonesians and Singaporeans in Hong et al., 2013) typically include cultural identification as a means to reinforce the external validity of cultural attachment. In order to measure cultural identifications, six questions measured on a 1 to 6 Likert's scale were used (Hong et al., 2013; Phua et al., 2017). Sample items include "How much do you agree with Singaporean culture?"

3.11.3 Parental Attachment

In order to measure maternal attachment, the parental bonding instrument (PBI; Parker et al., 1979; Parker, 1990) is used. In order to account for differences in parenting roles across cultures, paternal attachment is also measured using the same scale. The PBI measures the relationship between the individual and a parent (with separate scales for each parent) in two dimensions of care and overprotectiveness using 1 to 5 Likert's scales. Participants rated a list of 25 attitudes or behaviours on how much each item described their father or mother in their first sixteen years of life. For the Care subscale, some sample items were " spoke to me in a warm and friendly voice" and " did not help me as much as I need" (reverse-coded); for overprotectiveness subscale, some items were " tried to control everything I do" and " gave me as much freedom as I want" (reverse-coded).

3.11.4 Adult Attachment

Another exploratory comparison was to compare any differences or similarities between adult attachment and cultural attachment. Adult attachment was measured using the Experiences in Close Relationships scale created by Brennan and colleagues (Brennan et al., 1998) which used two dimensions: anxiety and avoidance. Similar to the cultural attachment dimensional scale, individuals have a secure relationship with the target only if their scores for both anxiety and avoidance are low. Each dimension contains 10 questions measured on a 1 to 5 Likert's scale.

3.11.5 Racial Essentialism

Racial essentialism measures whether individuals believe that racial categories have biological essences (Chao et al., 2007). Essentialists believe that racial categories are largely fixed and there are deep seated differences between members of different races. On the other hand, social constructionists believe that racial categories are arbitrary and malleable. In the case where individuals are racial minorities, essentialists are more likely to preserve, promote, and identify more strongly with their culture whereas social constructionists are more likely to identify and assimilate toward the majority culture (No et al., 2008). The scale used in this thesis (No et al., 2008) contains 8 items measured on a 6-point Likert's scale. Sample items include "To a large extent, a person's race biologically determines his or her abilities and traits."

3.11.6 Patriotism

Patriotism has been previously linked with physiological sensitivity to threat (Oxley et al., 2008) and is related to culture in this context due to the separation by national boundaries. In order to tease apart effects specific to patriotism, it is added as a control. Patriotism is measured using a scale modified from Huddy and Khatib, 2007 and Kosterman and Feshbach, 1989. 7 items were measured on a 7-point Likert' s scale. Sample items include “How important is being Singaporean to you?”

3.11.7 Need for Cognitive Closure

Need for cognitive closure has been shown to be related to promoting in-group behaviours (Kruglanski et al., 2006; Federico et al., 2005; Chao et al., 2010) and could thus influence response to cultural symbols (with the cultural group being a large in-group). Need for cognitive closure is measured using the NFC short scale (Roets and Van Hiel, 2011a) which was adapted from the NFC scale (Webster and Kruglanski, 1997). 15 items were measured on a 5-point Likert scale. Sample items include “I don't like situations that are uncertain” and “I don't like people who are capable of unexpected actions”.

3.11.8 Affect

The Positive and Negative Affect Schedule (PANAS, Watson et al., 1988) is used to measure the mood of the participant in the day leading up to the experiment. This is used as a control measure to identify emotionally volatile individuals with extreme positive and negative moods. 20 items (10 for each positive and negative) were measured on a 4-point Likert's scale. Examples of positive emotions include “interested”, “Proud”, and “Attentive”, whereas examples of negative emotions include

"Upset", "Jittery", and "Irritable".

3.11.9 Perceived Racism Scale

The perception of discrimination has been shown to be stressful to individuals trying to acculturate (McNeilly et al., 1996). In order to measure perceived discrimination, a section of the Perceived Racism Scale involving experiences was used (McNeilly et al., 1996). 14 items were measured using a 5-point Likert's Scale. Sample items include "Because of my ethnicity/nationality, people often assume I come from a poor and backward country" and "When I assert myself, I am looked upon as an exception to my ethnicity/nationality."

3.11.10 Acculturation Stress

In order to control for the prevailing stress levels of participants associated with acculturation processes, the Self-Rating Depression Scale (Zung, 1965) was used. 20 items were measured using a 4-point Likert's scale. Sample items include "I have trouble sleeping at night" and "I feel that others will be better off if I was dead".

3.11.11 Rating of Stimuli

Participants rated all stimuli shown to them during the experiment in a post-experiment survey. For threatening or non-threatening images, participants rated the images in terms of perceived threat ("How scared are you by this image?") and familiarity ("How familiar is this image?"). For secure base images, participants rated the images based on connected, attractiveness, and adequacy ("How Singaporean is this image?"). Ratings were based on a 5-point Likert's scale.

3.11.12 Subliminal Check

Participants were also asked to list down the contents of images that they saw. In general, participants were not expected to list down the content of multiple subliminal images. This question is used to identify participants that could clearly see the contents of the subliminal images.

3.11.13 Demographics and Multicultural Exposure

Participants provided basic information such as age, gender, and a simple family background. Participants also listed their experience with cultures other than their own. Questions here include the extent in which participants have stayed outside of their home country and the host country (if applicable). Other questions include the nationalities of their friends, favourite restaurants, and music they listen to.

3.12 Method 1 (Study 1): Skin Conductance Response

As mentioned in chapter 2.3, skin conductance response (SCR) is a non-invasive measure of autonomic nervous system activity which is commonly used as a biomarker of arousal. Researchers have used SCR to study emotional and threat processing. In fact, major physiological theories of emotion (e.g. Somatic Marker Hypothesis; Bechara et al., 2005; Damasio, 1996) suggest that a significant part of emotional experience lies in the bodily response. SCR are used in this study to measure the mitigation of threat in the presence of cultural symbols and was collected using exosomatic recording methods by applying a low constant voltage across the skin. The choice of measurement site affects the quality of SCR obtained. Areas with higher concentrations of sweat glands (specifically, eccrine glands) produce higher

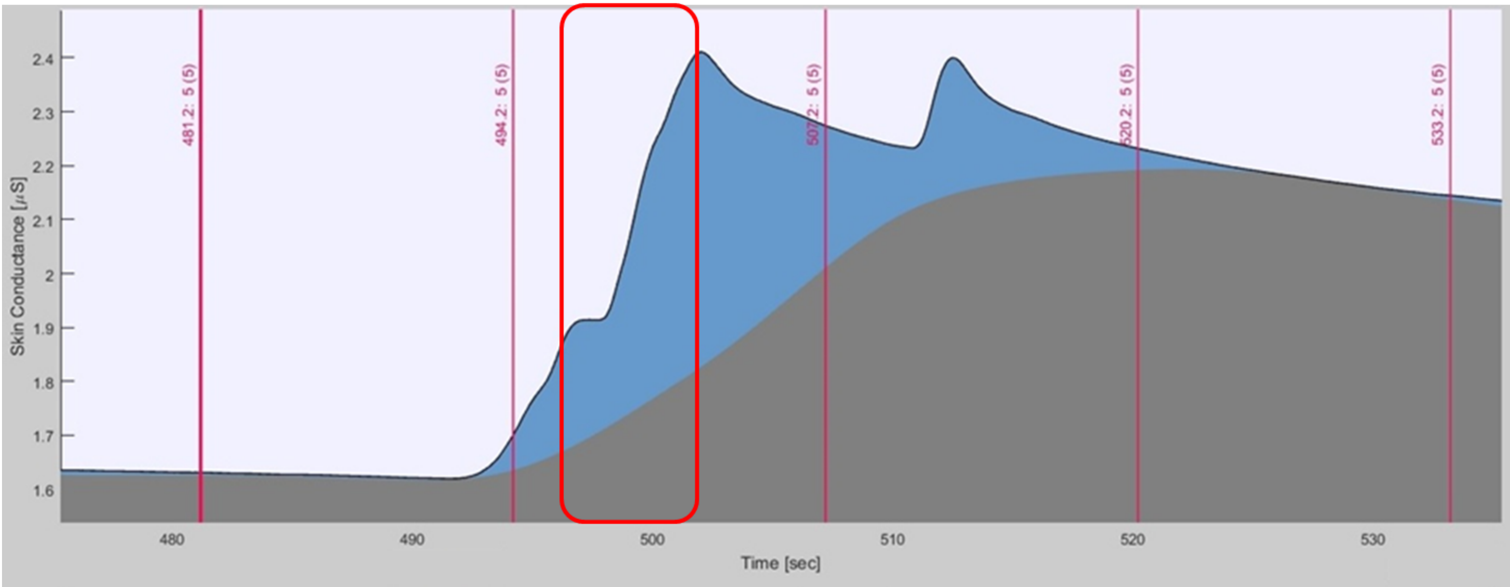

Figure 3.12: Example of skin conductance response. Each magenta line represents the onset of the first stimulus. Gray areas represent the tonic skin conductance response. Blue areas represent the phasic skin conductance response. The red rectangle highlights an arbitrary response window. The measure used in Study 1 is the integrated skin conductance response which is the blue area within the rectangle. Graph generated using Ledalab.

frequency of SCR (Martin and Venables, 1966). Previous research has shown that the palms and soles have the densest collection of eccrine sweat glands (Saga, 2002; Frewin and Downey, 1976; Andreassi, 1995, 2013) and are the most suitable regions for collecting SCR (Freedman et al., 1994; Scerbo et al., 1992). A comparison of 16 sites across the body shows that the fingers are suitable sites (van Dooren and Janssen, 2012). As such, in the study for this thesis, the distal phalanges of the index and middle fingers were chosen as measurement sites.

Traditionally, SCR were extracted using the classic trough-to-peak detection method. A response window was predefined (e.g. 1-4s after stimulus onset) and the peak response in this window was compared to a baseline (e.g. the average or lowest response from 0-1s after stimulus onset). However, responses obtained in this manner are often made unreliable by rapid events that cause the SCR to overlap. This sometimes resulted in experiment designs which required inter-trial intervals upwards of 10 seconds leading to boredom and multiple data collection sessions. Alexander and colleagues (Alexander et al., 2005) used the deconvolution of skin conductance data to allow the SCR to be extracted. This is done by introducing a suitable impulse response function (Bateman biexponential function with tau1 = 0.75 and tau2 = 2) to represent the tonic skin conductance. Subsequently, the phasic skin conductance is obtained from the difference of the total and the tonic skin conductance. This method was later improved to account for inter-individual differences and shorter inter-impulse intervals with the authors also introducing a computer script for it (Ledalab; Benedek and Kaernbach, 2010). The advantage of using Ledalab is its ability to separate phasic responses even in short inter-trial intervals. Previous tests (Benedek and Kaernbach, 2010) identified 2s as the shortest tested inter-trial interval so the analysis used (Continuous Deconvolution Analysis - CDA) is more than adequate to analyse responses in this thesis. The integrated skin conductance response (ISCR) is then extracted by calculating the area under the graph of the phasic skin conductance and entered into a linear mixed effects model. ISCR is recommended over peak SCR (amplitude) as it better accounts for variation within the response window (Benedek and Kaernbach, 2010). Study 1 uses a block design to maximise the signal from the skin conductance readings. As a result, a three-level mixed effects model will be used to analyse the data with block as a lower level grouping variable and participant as a higher level grouping variable. This allows us to account for idiosyncrasies of the individual and possible order effects in the presentation of the blocks.

3.13 Method 2 (Study 2): Functional magnetic resonance imaging

3.13.1 Introduction to fMRI

Functional magnetic resonance imaging (fMRI) is a non-invasive brain imaging technique that provides high spatial resolution images. fMRI allows researchers to infer neuronal activity in the brain by reliably measuring local changes in the cerebral blood flow (CBF; Ogawa et al., 1990, 1992). Despite its relatively low temporal resolution (in the order of seconds as compared to the millisecond recordings in electroencephalography and magnetoencephalography), the combination of safety, convenience and spatial clarity makes many researchers favour fMRI in human studies. Researchers typically employ this method to study the brain as a whole simultaneously and draw conclusions about different aspects of human behavior, such as sensory processing, voluntary action, and cognitive capabilities (Logothetis, 2008). fMRI can be used to study functional specialization (also known as functional segregation) and functional integration (Friston, 2004; Logothetis, 2008). Whilst the former examines the link between a function and isolated parts of the brain, the latter examines the engagement of different isolated parts in the brain to perform certain functions. In this study, fMRI is mainly used to answer questions concerning functional specialization/segregation by examining the activations both across the whole brain and in specific regions.

Specifically, fMRI measures the blood oxygen level dependent (BOLD) contrast in the brain. Metabolic demands in a region of the brain due to neuronal activation require more oxygen and correspondingly are met by an influx of oxygenated hemoglobin. Activated regions absorb more oxygen from the surrounding hemoglobin. This influx of oxygenated hemoglobin usually exceeds the cerebral metabolic rate ($CMRO_2$) causing the deoxygenated hemoglobin to be forced out of that brain region. The MRI scanner uses differences in the magnetic susceptibility of oxygenated hemoglobin and deoxygenated hemoglobin to identify areas of activation. A greater amount of deoxygenated hemoglobin leads to a larger BOLD response.

Two types of magnetic resonance (MR) images, namely T1-weighted and $T2^*$-weighted images, are obtained from the scanner using echo-planar imaging (EPI; Mansfield, 1977). T1-weighted images, also known as anatomical scans, capture the complex structure of the brain in high detail and clarity by taking advantage of properties of different tissue types found in the brain. $T2^*$-weighted images, also known as functional scans, capture temporal snapshots of the brain which indicate traces of neural activity (through BOLD activations) for use in, among other things, statistical modelling. As mentioned above, these images are captured by taking advantage of differences in magnetic susceptibility of oxygenated and deoxygenated hemoglobin.

As with many biological experiments, precautions are needed to maximise the signal-to-noise ratio of the collected data. One of those problems is the possible effects of presentation order. Traditionally, fMRI experiments utilized randomized block designs in order to maximise the signal from each condition. Due to the discovery of the near-linearity of the hemodynamic response (Dale and Buckner, 1997) and higher efficiency with lower inter-stimulus intervals (Dale, 1999), fast event-related design is possible and rose in popularity. Similar to skin conductance responses, simple linear deconvolution can be used to separate signal changes associated with different events (Boynton et al., 2012). In this thesis, a fully randomized event-related design was used to remove possible order effects in the design. On the other hand, BOLD measurements are susceptible to multiple sources of noise, including movement by the participant including those caused by breathing, heartbeat or otherwise. Although post-hoc compensation can be done with artefact correction, safeguards are put in place to reduce the noise and maximise the signal. Participants in the fMRI scanner were kept in position with a head guard device and instructed to remain as still as possible.

Finally, a key criticism of fMRI has been about the veracity of the precise nature of the coupling of the physiological blood flow with the underlying neuronal activity (Singh, 2012; Ekstrom, 2010). Although some scholars have shown that the peak hemodynamic response and electrophysiological activity (local field potential; LFP) in some regions of the brain occur in very close proximity (Logothetis et al., 2001; Logothetis, 2008; Heeger and Ress, 2002; Logothetis, 2012; Logothetis and Wandell, 2004), other have suggested that the CBF can increase without any neuronal activation in other regions (Buxton, 2013; Lin et al., 2010; Cardoso et al., 2012). In this thesis, differences between experimental conditions on BOLD-related neural activity are examined. As with other fMRI studies, conclusions formed from results in this thesis should be viewed under the lens of the current understanding of neurovascular coupling.

3.13.2 Statistical Analyses: fMRI

The common approach to data analysis and statistical comparison in fMRI studies is to use generalized linear models (GLM). GLMs in fMRI studies express BOLD activity over time as a linear combination of explanatory variables together with an error term (Friston et al., 1994). BOLD activity over time is modelled using a convolution of boxcar or delta functions and a canonical hemodynamic response function (HRF). Figure 3.13 (pg74 contains an example showing the convolution of the HRF with varying number of event onsets. The HRF models the biological process of oxygen replenishment in neurons while the boxcar or delta functions serve as indicators of event onsets (Friston et al., 1998). Boxcar or delta functions are derived from the explanatory variables in the GLM, also known as regressors, which usually include experimental conditions and confounding or nuisance covariates. Similar to the analysis of skin conductance responses, the aim is for idiosyncratic effects to be minimised and for the results to be generalizable. As such, a hierarchical mixed effects analysis is chosen over a fixed effects analysis. In a fixed effects analysis, the distribution of effects amongst participants is not taken into account which means that a small segment of the sample could be driving effects found in the group. On the other hand, a hierarchical mixed effects analysis implements a two-stage GLM where the fixed effects for each participant are estimated at the first level before the random effects for each participant are estimated and accounted for at the second level. In study 2, an event-related design is used with the trials from all experimental conditions presented in a fully randomised order. This lends itself to the two-level hierarchical analysis used as any effects of order or idiosyncrasies of the individual can be controlled and accounted for.

In the first level GLM, experimental conditions and parametric modulators are added as regressors. Parametric modulators, which usually vary on a trial by trial basis for each participant, are entered into the first level GLM to account for individual response differences or effects of nuisance trial characteristics. Each parametric modulator is analysed separately from the next because of possible order effects occurring (Mumford et al., 2015). In the second level GLM, betas or contrast estimates obtained from the first level GLM and other participant level covariates are added as regressors. Participant level differences, such as self-reported measures, are correlated with participant level mean BOLD activity to examine possible moderation effects. Similar to parametric modulators, participant level differences are input-order dependent and as such, analysed separately from the next.

A statistical parametric map (SPM) is produced by thresholding corresponding p-values of the estimated betas of the GLM in each voxel in the brain. Since there are more than 20,000 voxels in the brain, a correction for multiple comparisons is needed to reduce type I errors (false positives). Traditionally, the Bonferroni correction is used but it has been criticised as an over conservative correction which is likely to increase type II errors (false negatives) due to the large n ($>$20,000). Instead, as the correlation across adjacent voxels are high, by applying the Random Field Theory, p-values are adjusted whilst the values of neighbouring voxels are taken into account (Friston, 2004). The correction under Random Field Theory tends to be much lower than the Bonferroni correction. The p-values after adjustment is known as the family-wise error (FWE) corrected p-values.

In conjunction with using FWE corrections, region-of-interest (ROI) analyses were also used to reduce type I errors. By pre-defining a smaller brain region based on previous findings and anatomical maps, the number of statistical comparisons made and noise from other regions of the brain are reduced considerably. The different ways used to define ROI regions in this thesis are by relying on previous definitions in the Automated Anatomical Labeling (AAL; Tzourio-Mazoyer et al., 2002), or relying on Talairach Daemon database labels (TD; Talairach and Tournoux, 1988), or by defining a sphere centred on a peak voxel established in prior literature. The AAL and TD databases are two different databases with slightly different segmentation and labelling of brain regions. Each of these databases has unique strengths in their segmentation which allow for more adequate examination of a certain region of interest. These databases are useful in identifying small, specific regions of interest and to identify general regions of the brain where there is insufficient prior literature to rely on. However, in order to locate brain activations in a specific subset of voxels in a bigger brain region, a sphere centred on a previously located peak voxel can be used.

Lastly, two thresholding methods were used to identify significant brain activations in this thesis. Following recommendations to employ less stringent correction measures (Liberman, 2009), a voxel-wise and cluster-wise threshold of uncorrected $p < 0.001$, and cluster size, $k > 10$, was used. However, in order to identify activations which were more robust, a stricter family-wise error corrected voxel-wise threshold of $pFWE < 0.05$ was used as well. This is in line with up-to-date statistical recommendations (Woo et al., 2014; Yeung, 2018).

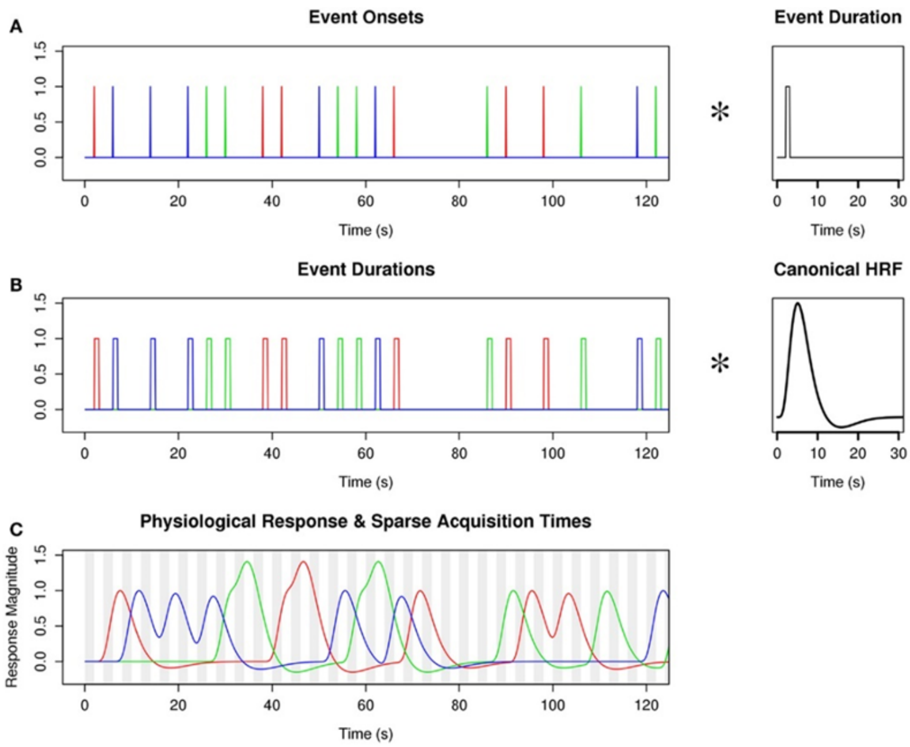

Figure 3.13: Relationship between event onsets and HRF (c.f. Perrachione & Ghosh, 2013).

Chapter 4

Study 1

In chapter 2.2, parallels were drawn between parental, adult and cultural attachment. The notion that an attachment target (such as the parent or partner) acts as a secure base when the individual is threatened has been well tested and established (e.g. Mikulincer et al., 2001b; Ainsworth et al., 1978). Initial studies of cultural attachment (Hong et al., 2013) suggest that cultural attachment follows similar principles where the effects of the security provided by cultural symbols are observed in individuals when they are threatened. As described in the earlier chapters and illustrated using the conceptual model (Fig 2.2), there are gaps in the current understanding of the biological mechanisms underlying attachment and cultural attachment. At the end of chapter 2, three research questions were proposed to bridge the gaps identified. This study aims to answer the first question by providing initial biological evidence of the effects of cultural symbols on the individual's emotional processing of threat. Additionally, the study also seeks to identify the circumstances or types of individuals which/who cultural symbols have a greater effect on.

As explained in Chapter 3, the experimental paradigm chosen in this study is adapted from previous adult attachment and cultural attachment studies. To measure the mitigating effect of cultural secure bases towards threatening stimuli, participants are exposed to threatening stimuli followed by a cultural secure base. At the same time, exosomatic measurements of SCR were taken. Major physiological theories of emotion (e.g. Somatic Marker Hypothesis; Bechara et al., 2005; Damasio, 1996; chapter 2.4) suggest that a significant part of emotional experience lies in the bodily response. SCR is one such bodily response that is commonly used as biomarker of arousal to study emotional and threat processing. The attachment system has been suggested to be an emotion regulation device (Vrticka and Vuilleumier, 2012) and insecure attachment styles have been associated with heightened SCR in response to stress (e.g. Sroufe and Waters, 1977b; Dozier and Kobak, 1992; Roisman et al., 2004; Gander and Buchheim, 2015). Similarly, in this study, an individual's SCR is expected to rise when under threat without an effective secure base. However, when both threatened and provided with a comforting cultural secure base, the SCR are expected to remain the same. This leads to the main hypothesis (H1) of this study below.

H1: The increase in SCR when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neutral acultural symbols).

Since there are differences in parental and adult attachment styles, it is possible that there are similar differences in cultural attachment as well. In order to identify these differences, a measure of different dimensions of cultural attachment has been included. The levels of security, relative significance, boundarylessness, and sacredness of culture were measured to identify if specific attitudes toward culture moderated the mitigation of SCR responses towards threats. The following hypotheses describe the expected moderation (if any):

H2a: Individuals who feel more security towards their culture are more likely to experience a lower increase in SCR than individuals who feel less security.

H2b: Individuals who view their worth in their cultural group as more significant are more likely to experience a lower increase in SCR than individuals who view their worth as more insignificant.

H2c: Individuals who view culture as having more boundaries are more likely to experience a lower increase in SCR than individuals who view culture as having fewer boundaries.

H2d: Individuals who are more likely to view culture as being sacred are more likely to experience a lower increase in SCR than individuals who are less likely to view culture as being sacred.

In addition to the differences of attitudes toward culture, prior attachment experience could also be potential moderators. In this study, the role of parental attachment is examined. Parental attachment affects adult attachment in the same direction (i.e. an individual with secure parental attachment styles is more likely to experience secure adult attachment). One can expect parental attachment to moderate cultural attachment in the same way. However, there is a counter argument that individuals with secure personal attachments do not need rely on culture as a source of support and security. As such, the following hypotheses have been set up as competing ones (i.e. parental attachment moderates cultural attachment but the direction is unclear).

H3a: Individuals who viewed their parent (i-Father, ii-Mother) as being more caring are more likely to experience a lower increase in SCR than individuals who view their parent as being less caring.

H3b: Individuals who viewed their parent (i-Father, ii-Mother) as being more caring are more likely to experience a higher increase in SCR than individuals who view their parent as being less caring.

H4a: Individuals who viewed their parent (i-Father, ii-Mother) as being more overprotective are more likely to experience a lower increase in SCR than individuals who view their parent as being less overprotective.

H4b: Individuals who viewed their parent (i-Father, ii-Mother) as being more overprotective are more likely to experience a higher increase in SCR than individuals who view their parent as being less overprotective.

In chapter 2.3.1, individual differences commonly associated with cultural differences were listed. At the same time, possible confounds were also identified. The following hypotheses have been set up to address possible moderation or confounding effects.

H5: NFC moderates the increase in H1 such that individuals with higher NFC will experience a smaller increase in SCR than individuals with lower NFC.

H6: Racial essentialism moderates the increase in H1 such that individuals who hold more essentialist beliefs will experience a higher increase in SCR than individuals who hold more constructionist beliefs.

H7: The lowered increase in SCR described in H1 is not moderated by the following confounding variables, a) patriotism; b) positive affect; c) negative affect; d) familiarity.

Additionally, the reaction time of the individual in indicating the direction of the arrow was also taken in account as a dependent variable. Although reaction time measures have been included in the previous experiments, many of those experiments manipulate the congruence or valence of statements rather than have participants react to actual threats. The link between reaction time and SCR is not established so this study takes a exploratory stance to investigate if such a link exists. As such, further discussion will be carried out in a later section.

4.1 Materials and Methods

This study was approved by the institutional review board of Nanyang Technological University (NTU).

4.1.1 Participants

Singaporean participants were recruited via an online recruitment system at NTU. The study was conducted in two parts: an online questionnaire component and a laboratory experiment session. The online questionnaire was administered at least one week prior to the laboratory session to reduce priming effects of the questionnaire or experiment stimuli. Participants who did not complete more than 70% of the online questionnaire or completed the questionnaire too quickly (i.e. 2 minutes compared to the average of 10-12 minutes) were excluded from the next part of the study. Additionally, participants who stayed in a foreign country for more than six months consecutively were also excluded from the study. The remaining participants were invited for the experiment session. Participants who completed the laboratory session (n = 56; 34 females; M_{age} = 22.10; SD = 1.739) were paid SGD20 at the end of the experiment session.

4.1.2 Online questionnaire

The online questionnaire consisted of the parental bonding instrument (Parker et al., 1979), cultural attachment scale (Categorical; Svetlana et al., 2016), racial essentialism scale (No et al., 2008), patriotism scale (Huddy and Khatib, 2007; Kosterman and Feshbach, 1989), need for cognitive closure scale (Roets and Van Hiel, 2011a; Webster and Kruglanski, 1997), and demographic information including the extent of their experiences living outside of Singapore. The online questionnaire, together with other surveys completed during the experiment session, was hosted on an external online survey platform (Qualtrics, Provo, UT).

4.1.3 Experimental Procedures

Participants signed an informed consent form upon their arrival at the laboratory. Subsequently, they completed a self-reported mood check (PANAS; Watson et al., 1988) before washing and drying their hands. A research assistant then helped the participant into their seat as well as adjusted the height of the chair and chin rest to a comfortable level for the participant. The eye level of the participant was kept as close to the centre of the computer screen as possible. The chin rest was placed 60 cm away from the computer screen. Participants were then connected to the skin conductance device by placing silver chloride electrodes on the distal phalanges of their index and middle fingers. They were then told to relax and shown instructions for the task on the computer screen. Participants rested for eight to ten minutes before the experiment was started.

4.1.4 Experimental Task Setup

Each participant completed 45 trials in 5 blocks. The first block consisted of 5 practice trials for participants to habituate to the task. Images presented in the practice trials were unused neutral images. Subsequent blocks consisted of 10 images from one of four conditions (2 by 2: Threat or Non-threat by Singaporean or Control). The order of blocks and images within those blocks were randomised between participants. Figure 4.1 (pg82) contains a summary of one trial in the task. At the start of each trial, a fixation cross appears on the screen for 4000 ms with a random jitter of mean 500 ms and capped at 5000 ms. Random jitters were used in the experiment to reduce anticipation from the participant (Foxe et al., 2012). Following that, a threat or non-threat image was displayed for 200 ms. An arrow, randomly chosen to point either to the left or the right in each trial, was also presented in the middle of the screen. A secure base image was then subliminally displayed for 30 ms before a pixelated version of the secure base image was used as a backward mask and shown for 3700 ms with a random jitter of mean 500 ms capped at 4700 ms. The secure base image used was the one overlaid onto the forward mask with both images at 50% transparency. Two options ("Left" and "Right") then appeared on the screen. Participants had 600 ms to indicate the direction of the arrow via a button press. Participants were instructed to answer as quickly as they can. The time participants took to make their choice was recorded as their reaction time to the arrow. The choice made by participants was highlighted in red for 200 ms. If participants failed to make a choice, an error screen appeared for 200 ms. The total time for the experiment was about 7 to 8 minutes. Feedback about the correctness of their choices was not given during the task. In order to ensure that participants were economically motivated, SGD5 was given to participants who made correct responses 90% of the time. Stimuli were presented on the computer monitor (with refresh rate of 60 Hz) using the Psychtoolbox package

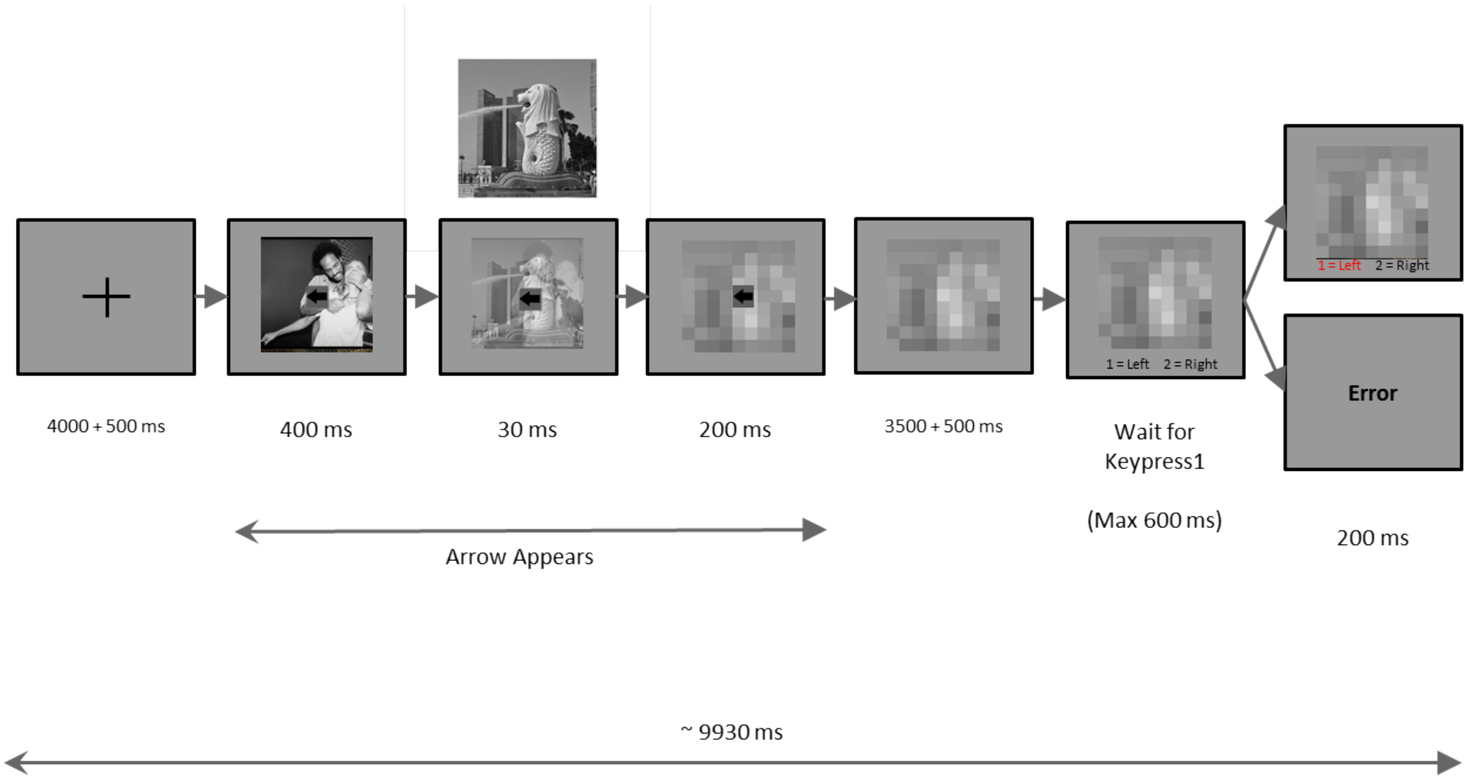

Figure 4.1: Summary of the task. A fixation cross appeared followed by the presentation of a supraliminal image (threatening or not). The participant had to report the direction of the arrow overlaid to the image. A second image (cultural symbol or control) was subliminally presented (30 ms) followed by a pixelated version of the first image (200 ms). Subsequently, the participant had to report the direction of the arrow.

(Brainard and Vision, 1997; Kleiner et al., 2007; Pelli, 1997) in Matlab (Mathworks). Psychtoolbox has been previously used in experiments with subliminal presentation (Zebrowitz et al., 2008).

4.1.5 Materials

Images used in this study were tested in Pre-Study 1 and Pre-Study 2 (see Chapter 3). Five of the most representative images were chosen for each of the experimental conditions (Threat, Non-Threat, Singaporean, and Control). Participants undertook 4 blocks in each experiment of 10 trials each. In each block, participants either saw threatening or non-threatening trials and either Singaporean or control images. In each trial, the threatening or non-threatening image was presented before the Singaporean or control secure base image. As such, each of the five images was presented twice in each block and four times throughout the experiment. The order of presentation of blocks and images were randomised for each participant. Additionally, the computer ensured that image pairs from each trial were not repeated in the same experiment.

4.2 Analysis

4.2.1 Skin Conductance Response Preprocessing

Event-related responses were extracted from the raw data using Ledalab's (Benedek and Kaernbach, 2010) continuous decomposition analysis performed in Matlab (Mathworks). Data was down sampled from 1000 Hz to 10 Hz. On top of that, in order to remove high frequency noise (typically electromagnetic disturbances from the environment such as lights), the data was low-pass filtered (5Hz, first-order

Butterworth). Subsequently, the event related phasic driver of the electrodermal activity (from 1-4s after the first image of each trial is shown) was extracted. The current paradigm allows for two windows to be tested. The response window used here measures SCR after the participant is exposed to the stimulus but before the participant makes the keypress. Further analysis was performed on a separate window (from 5 to 8s) to determine if there was any difference in the response patterns. All the results discussed do not differ - regardless of response window. Two dependent variables are obtained: average phasic driver (SCR) and the integrated area of the phasic driver (ISCR). Analyses performed on SCR and ISCR did not yield differences in results. Following recommendations from (Benedek and Kaernbach, 2010), only the ISCR results are reported and discussed.

Results obtained in the practice trials were excluded from the analysis. Remaining data from 40 trials were further evaluated for reliability following recommendations of de Berker and colleagues (2016). Trials with ISCR three standard deviations higher than the sample mean were discarded. Similarly, trials with rapid rate of change (second differential was three standard deviations higher than the mean sample second differential) were also discarded. The excluded trials were considered to be artefacts due to excessive movement or adjustment of the electrode and very unlikely to be related to the experimental conditions. Trials in which participants made errors or did not respond were also discarded. Due to the quick presentation timing of the subliminal image, participants were assumed to be distracted in trials where errors were made or missed entirely. Subsequently, 19 participants were excluded from the analysis due to their low number of threat trials which registered valid ISCR (<3 of 20). After a comparison of demographics between the included and excluded group showed no difference, these participants were deemed to be insufficiently aroused by the images for idiosyncratic reasons. In order to preserve the novelty of the images, we were only able to assess the threat participants felt post-hoc and naturally remove participants that were not aroused by these images (but could nevertheless have been aroused by stronger stimuli). The data for the remaining 37 participants (21 females; M_{age} = 21.97; SD = 1.739) are statistically analysed below.

4.2.2 Statistical Analysis: linear mixed effects models

In this study, ISCR and reaction time were set up as independent variables. The experimental conditions and individual differences measured using scales were set up as dependent variables. In order to correctly account for the nested structure of responses within participants between different conditions and control for the non-independence, linear mixed effects models were used to analyse the data (Hox, 2002; Raudenbush and Bryk, 2002). All analyses performed included participants as a grouping variable. The models used were random slope and random intercept models to account for as much idiosyncratic variation as possible. The parameter estimates were obtained using the restricted maximum likelihood (REML) estimation method which produces relatively unbiased estimates (Harville, 1977). However, the Akaike information criterion (AIC) and log-likelihood values can only be obtained by using the same models with the maximum likelihood (ML) estimation method.

Data analyses were completed in R (R Core Team, 2011/2), using the lme4 package (Bates et al., 2014). Tables were created using the stargazer package (Hlavac, 2014) in R. Graphs were created using ggplot2 (Wickham, 2016) and ggpubr (Kassambara, 2017) packages in R. ISCR scores were log-transformed using y = log (1+x) to standardize the positively skewed distributions of SCR magnitudes before any further analysis. Reaction time measures were also log-transformed for similar reasons. All questionnaire and reaction time measures were centralised as well to improve convergence during the maximum likelihood estimation. The Kenward-Roger approximation for degrees of freedom was used in obtaining p-values by using the pbkrtest package in R (Halekoh and Hojsgaard, 2012). Variance inflation factor (VIF) calculations were made using recommendations from the works of Nakagawa and Schielzeth (2013).

Using the power analysis calculator from (Judd et al., 2017), with an estimated effect size of 0.3, variance partitioning coefficients based on the model examining the two-way interaction between experimental conditions to test for H1 (Table 4.8), and expected power of 0.8, the minimum number of participants needed to power the study is 37. Reversing the analysis of the results using the same model, the power of the study is 0.791 which is near the recommended level of 0.8 (Judd et al., 2017; Brysbaert and Stevens, 2018).

4.3 Results

4.3.1 Manipulation Check

Post experiment image ratings were in tandem with their expected effect: threatening images received higher ratings than not-threatening ones in the related question (M_{Threat} = 3.702, SD = .820; $M_{\text{Non-Threat}}$ = 1.470, SD = .550; $t(57) = 22.52$, $p < 0.001$). Cultural secure base images received higher scores (M_{Cultural} = 4.486, SD = .385) in the question "How Singaporean is this image?" as compared to control images (M_{Control} = 3.000, SD = 1.206; $t(57) = 9.075$, $p < 0.001$). In addition, a significant positive correlation was found between the connection ratings of Singaporean images and the CA security subscale ($r(35) = 0.328$, p = 0.013). No such correlation was found in control images ($r(35) = 0.014$, p = 0.913). Participants did not register unusually high positive (M_{positive} = 2.751; SD = 0.819) or negative (M_{negative} = 1.618; SD = 0.710) emotions prior to the experiment.

4.3.2 Descriptive statistics of individual differences

Table 4.1 and 4.2 show the summary statistics as well as correlation values of the individual difference measures collected in the study. All four subscales of cultural attachment are significantly correlated to the patriotism measures used. Since countries are used as the representation of culture in this thesis, overlaps in these measures are expected. However, since the highest correlation is only 0.557, there is still room for distinction between cultural attachment and patriotism. The parental bonding scales are also moderately correlated where care is typically negatively correlated with overprotectiveness even between different parents. Although cultural AT suggests that cultural attachment could be modelled after parental attachment, the only correlation between the two scales is a mild negative correlation (r = -0.326) between the level of maternal care and the cultural security subscale.

4.3.3 Test of Hypotheses

Before testing for hypotheses, a preliminary analysis (Table 4.3) revealed that the SCR of participants tended to be lower as time passes in the experiment (b_{onset} = -0.012, SE = 0.004, p = 0.009). In order to properly control for this in further models, the onset timing for each trial is added as a random effect in all of the following models. Other than onset time, there were no other significant main effects on ISCR. Similar analyses performed on the reaction time of participants yielded no significant effects for main effects. To keep models consistent, further mixed models of RT also control for onset times. Lastly, to address possible issues with biased sample selection, the results for same analyses performed on the full sample (without removal of participants) can be found in Appendix C. The main results of the study remain unchanged.

4.3.3.1 ISCR: Interaction effects of experimental conditions

To test for H1, the model in Table 4.5 was used to examine the interaction effects of threat and secure base on ISCR. There is a significant two way interaction effect (Figure 4.2, pg96; $b_{\text{threat*cultural}} = 0.015$, $SE = 0.007$, $p = 0.03$). SCR to threatening images followed by a neutral image are higher than SCR to non-threatening images which are also followed by a neutral image ($M_{\text{threat*control}} = 0.061$, $SE = 0.007$; $M_{\text{non-threat*control}} = 0.046$, $SE = 0.006$, $t(58) = -2.470$, $p = 0.016$, Cohen's d = 0.406) and also higher than the conditions when either threatening or non-threatening images were followed by a cultural image ($M_{\text{threat*cultural}} = 0.049$, $SE = 0.006$, $t(58) = -2.760$, $p = 0.007$, Cohen's d = 0.353; $M_{\text{non-threat*cultural}} = 0.048$, $SE = 0.005$, $t(58) = -2.650$, $p = 0.010$, Cohen's d = 0.300). Additionally, there were no significant differences between threatening and non-threatening images in the presence of cultural images ($t(58) = 0.0490$, $p = 0.96$). This result highlights the difference between cultural and neutral secure base conditions where threat had an effect in the neutral condition but the effect was reduced or removed in the cultural condition. The results here support H1.

Table 4.1: Descriptive Statistics of Individual Differences

Scale	N	Mean	SD	Min	Max	Skew	Kurt	p_{DP}
Age	37	21.973	1.740	19	28	1.18	3.30	0.00
CA-Security	37	19.270	2.479	12	24	-0.43	1.27	0.13
CA-Insignificant	37	13.757	3.077	7	20	0.06	-0.22	0.94
CA-Boundarylessness	37	15.595	3.312	7	22	-0.23	-0.007	0.83
CA-Sacredness	37	13.297	3.471	7	20	0.60	-0.57	0.22
Paternal Care	37	14.162	7.988	1	33	0.18	-0.72	0.57
Paternal Overprotectiveness	37	26.649	5.775	16	38	0.27	-0.53	0.61
Maternal Care	37	10.541	6.669	0	31	0.86	1.02	0.03
Maternal Overprotectiveness	37	25.189	6.271	11	37	-0.45	-0.46	0.42
Need For Closure	37	4.014	0.602	3.067	5.533	0.65	0.44	0.20
Racial Essentialism	37	3.561	0.629	2.000	4.750	-0.34	0.22	0.64
Patriotism	37	37.459	6.216	24	48	-0.41	-0.35	0.51

Note: CA = Cultural Attachment; p_{DP} refers to the p-value for the D'Agostino Pearson normality test and the distribution is non-normal when $p_{DP} < 0.05$.

Table 4.2: Correlation values (r) of Individual Differences

	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
[1] Age	0.053	−0.011	0.248	0.143	0.142	0.347*	0.111	0.102	−0.335*	−0.046	0.019
[2] CA-Security		−0.205	−0.338*	0.410*	−0.079	0.288	−0.326*	0.001	0.034	−0.066	0.388*
[3] CA-Insignificance			0.262	0.006	0.338*	−0.103	0.098	−0.295	0.290	0.260	−0.391*
[4] CA-Boundarylessness				−0.141	−0.044	−0.014	0.010	0.070	−0.162	−0.157	−0.417*
[5] CA-Sacredness					0.039	0.048	−0.127	−0.122	0.197	−0.053	0.557**
[6] Paternal Care						−0.284	0.559**	−0.355*	0.376*	0.107	−0.099
[7] Pat Overprotectiveness							−0.111	0.614**	−0.205	−0.086	−0.010
[8] Maternal Care								−0.306	0.069	−0.034	−0.055
[9] Mat Overprotectiveness									−0.120	−0.041	−0.186
[10] Need for Closure										0.398*	0.113
[11] Racial Essentialism											−0.198
[12] Patriotism											

Note: CA = Cultural Attachment; *$p<0.05$; **$p<0.01$; Column numbers correspond to their respective row numbers (i.e. [1] refers to Age and so on).

4.3.3.2 ISCR: Interaction effects of experimental conditions and individual differences

On top of the interaction between the experimental conditions, other interaction effects were also tested for the rest of the hypotheses (H2a to H7). Only significant effects are reported here. The different types of effects tested are two-way interaction effects between an experimental condition (threat or secure base) and an individual difference as well as three-way interaction effects between both experimental conditions and an individual difference. Two types of individual differences, the insignificance subscale of cultural attachment and need for cognitive closure, produced significant interactions. Their results are shown in Tables 4.6 and 4.7 and discussed separately below. The results below support H2b and H5. The lack of moderation from the confounding variables show support for H7. Results do not support H2a, H2c, H2d, the entire H3, the entire H4, and H6.

CA (Insignificance)

There was a significant two-way interaction between cultural attachment (insignificance) and the type of secure base shown. The feeling of insignificance in the context of culture affected ISCR responses towards cultural symbols regardless of threat (b = 0.004, SE = 0.002, p = 0.04). However, there was also a significant three-way interaction (b = 0.006, SE = 0.002, p = 0.04) between the presence of threat, type of secure base, and cultural attachment (insignificance).

Figure 4.3 (pg 96) shows this three-way interaction. Participants who scored higher on the subscale thought of themselves as being insignificant in comparison to their culture. These participants produced lower bodily responses during threat when also shown Singaporean images over neutral images. This shows support for H2b.

Table 4.3: Linear mixed effects models of ISCR (Main effects of experimental conditions)

	Dependent variable:				
	Integrated Skin Conductance Response				
	(1)	(2)	(3)	(4)	(5)
Intercept	.053***	.049***	.053***	.053***	.065***
	(.005)	(.005)	(.006)	(.005)	(.012)
Threat		.008			
		(.005)			
Secure Base			.001		
			(.004)		
log(Onset Time)				−.012***	
				(.004)	
log(Reaction Time)					−.031
					(.025)
Observations	1,259	1,259	1,259	1,259	1,259
Log Likelihood	1,745.893	1,745.846	1,741.818	1,746.920	1,744.153
Akaike Inf. Crit.	−3,481.787	−3,473.692	−3,465.636	−3,475.840	−3,470.305
Bayesian Inf. Crit.	−3,456.096	−3,427.449	−3,419.393	−3,429.598	−3,424.063

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
Models (1) to (4) are in the form of: ISCR ∼ IV + (IV|Participant/Block) where IV(1)=1; IV(2)=Threat; IV(3)=Secure Base; IV(4)=log(Onset Time); IV(5)=log(Reaction Time).

Table 4.4: Linear mixed effects models of ISCR

(Two-way interactions of experimental conditions)

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.049***
	(.006)
Threat	.002
	(.006)
Secure Base	−.004
	(.005)
Threat*Secure Base	.015**
	(.007)
Observations	1,259
Log Likelihood	1,746.989
Akaike Inf. Crit.	−3,453.978
Bayesian Inf. Crit.	−3,351.217

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
The model used here is: ISCR $\sim$ Threat*Secure Base + (Threat + Secure Base|Participant/Block) + (log(Onset Time)|Participant).

Need for Cognitive Closure

There was no significant two-way interaction for NFC. Instead, there was a significant three-way interaction (b = 0.027, SE = 0.013, p = 0.04) between the presence of threat, the type of secure base, and NFC. Figure 4.4 (pg98 shows the three-way interaction. However, the differences between the condition as shown in Figure 4.5 (pg98 highlights the differences between the conditions in a clearer fashion. It shows the difference in responses in the presence and absence of threat in each secure base condition with varying levels of NFC. In the presence of cultural secure bases, participants with higher NFC showed lower responses when threatened and conversely, participants with the lack of cultural secure bases showed higher responses when threatened. Participants with lower need for cognitive closure do not show these differences. This shows support for H5.

4.3.4 ISCR: Other main effects

For completeness, the main effects of each experimental condition and individual difference on ISCR is also examined and the results reported below. Although these analyses do not contribute directly to any hypotheses, they serve to guide future research.

4.3.4.1 Threat

Model 2 (Table 4.8) examined the main effect of threat on ISCR. Although there was a trend, threatening images did not generate significant higher SCR than non-threatening images (b_{threat} = 0.008, SE = 0.004, p=0.092).

Table 4.5: Linear mixed effects models of ISCR

(Two-way interactions of experimental conditions)

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.049***
	(.006)
Threat	.002
	(.006)
Secure Base	$-$.004
	(.005)
Threat*Secure Base	.015**
	(.007)
Observations	1,259
Log Likelihood	1,746.989
Akaike Inf. Crit.	$-$3,453.978
Bayesian Inf. Crit.	$-$3,351.217

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01
The model used here is: ISCR $\sim$ Threat*Secure Base + (Threat + Secure Base|Participant/Block) + (log(Onset Time)|Participant).

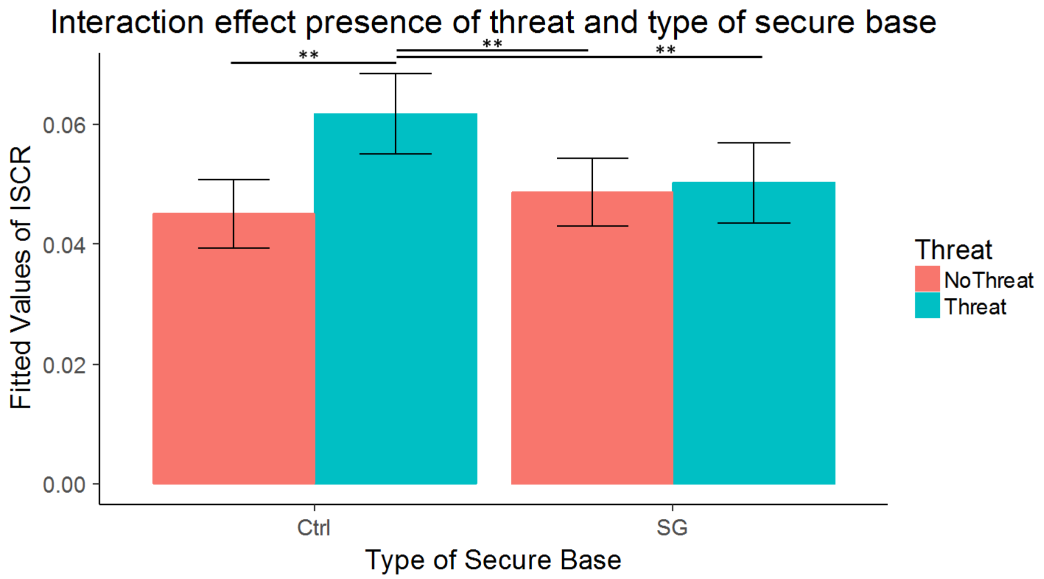

Figure 4.2: Two-way interaction effect of presence of threat and type of secure base on ISCR. The condition in which threatening images are shown with neutral images produced significantly higher SCRs than the other three conditions. Note. ** indicates significant differences with $p<0.05$. Error bars denote +/- 1 standard error.

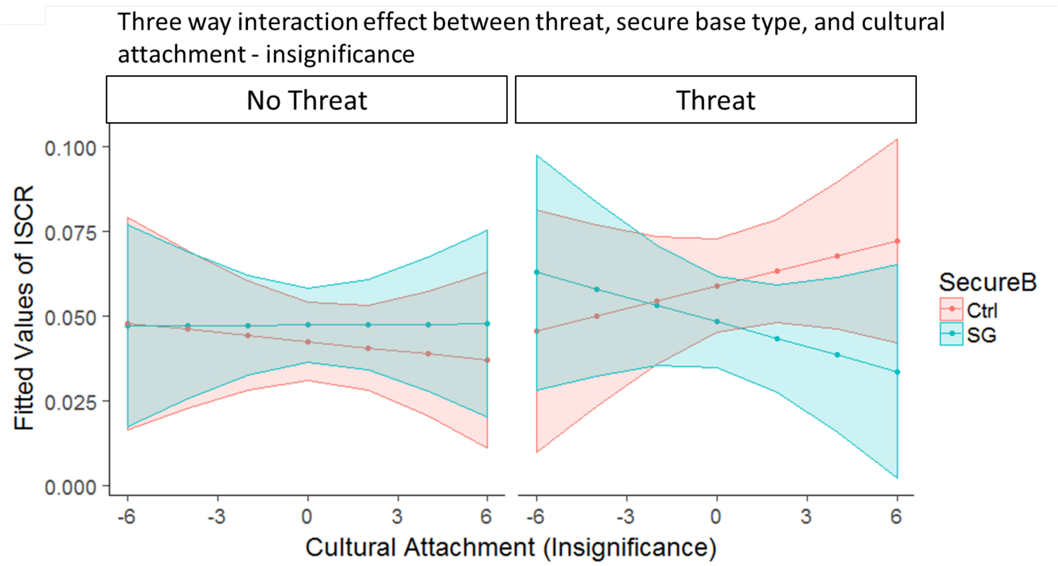

Figure 4.3: Three way interaction of the presence of threat, type of secure base, and cultural attachment (insignificance). Individuals higher in the CA subscale respond differently to threatening images when shown cultural versus neutral images. Individuals higher in the subscale show lower SCR when shown Singaporean images as compared to neutral images. Shaded areas represent +/- 1 standard error.

Table 4.6: Linear mixed effects models of ISCR

(Three way interaction with Threat/Secure Base)

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.048***
	(.006)
Threat	.001
	(.006)
Secure Base	$-$.005
	(.005)
CA-Insignificance	0.0000
	(.002)
Threat*Secure Base	.016**
	(.007)
Threat*CA-Insignificance	$-$.002
	(.002)
Secure Base*CA-Insignificance	$-$.001
	(.002)
Threat*Secure Base*CA-Insignificance	.006**
	(.002)
Observations	1,259
Log Likelihood	1,728.858
Akaike Inf. Crit.	$-$3,393.717
Bayesian Inf. Crit.	$-$3,229.298

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01
The model used here is: ISCR $\sim$ Threat * Secure Base * CA–Insignificance + (Threat + Secure Base + CA–Insignificance|Participant/Block) + (log(Onset Time)|Participant).

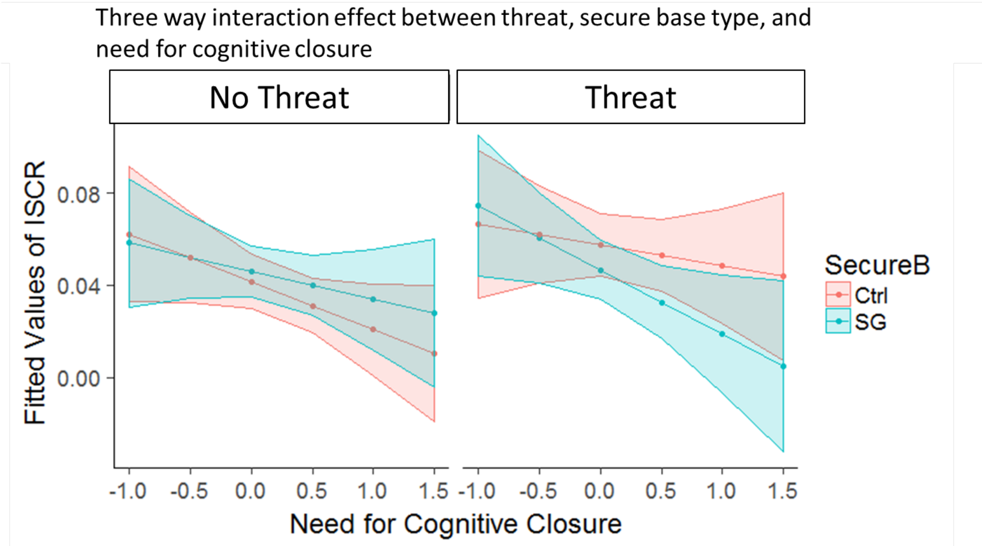

Figure 4.4: Three way interaction of the presence of threat, type of secure base, and cultural attachment (insignificance). Individuals higher in the CA subscale respond differently to threatening images when shown cultural versus neutral images. Individuals higher in the subscale show lower SCR when shown Singaporean images as compared to neutral images. Shaded areas represent +/- 1 standard error.

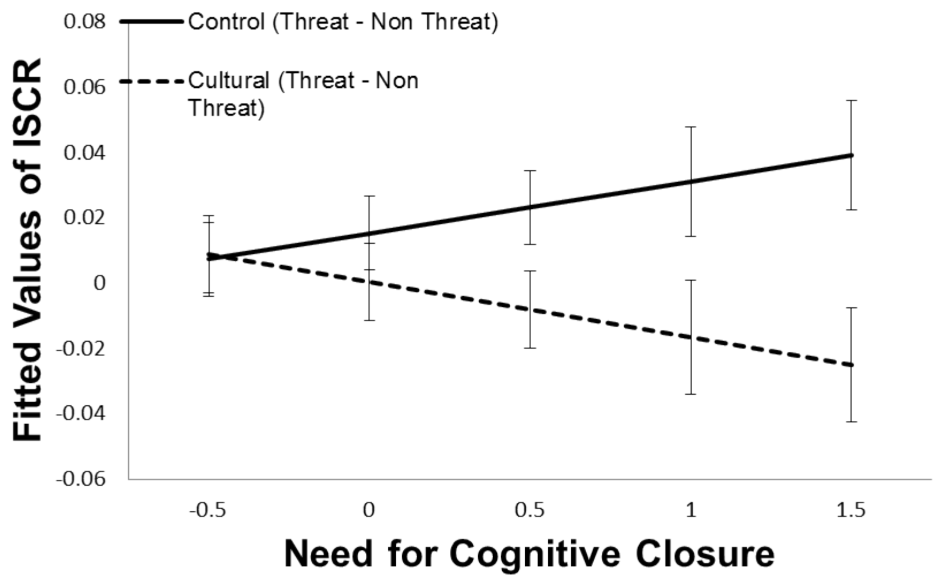

Figure 4.5: Three way interaction of the presence of threat, type of secure base and need for cognitive closure on ISCR. Individuals with higher NFC discriminated between different types of secure base images to produce significantly different SCRs. Note. ** indicates significant differences with $p<0.05$. Error bars denote +/- 1 standard error.

Table 4.7: Linear mixed effects models of ISCR

(Three way interaction with Threat/Secure Base)

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.046***
	(.006)
Threat	.001
	(.006)
Secure Base	$-$.005
	(.005)
NFC	$-$.012
	(.011)
Threat*Secure Base	.016**
	(.007)
Threat*NFC	$-$.016
	(.011)
SecureB*NFC	$-$.009
	(.010)
Threat*SecureB*NFC	.027**
	(.013)
Observations	1,259
Log Likelihood	1,735.023
Akaike Inf. Crit.	$-$3,406.046
Bayesian Inf. Crit.	$-$3,241.628

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
The model used here is: ISCR $\sim$ Threat * Secure Base * Need For Cogntive Closure + (Threat + Secure Base + Need For Cogntive Closure|Participant/Block) + (log(Onset Time)|Participant).

4.3.4.2 Secure Base

Model 3 (Table 4.8) examined the main effect of the type of secure base on ISCR. Trials showing subliminal cultural images did not produce significantly different ISCR from control trials (b_{cultural} = 0.003, SE = 0.004, $p > 0.1$).

4.3.4.3 Individual differences

After controlling for onset time, there were no significant main effects of individual differences on ISCR. Participants with a higher need for cognitive closure (b_{NFC} = -0.014, SE = 0.010, p = 0.10) produced marginally lower SCR. Tables 4.9, 4.10, 4.11, and 4.12 shows the results of these models. It is important to note that these results were discussed without any corrections made for the multiple individual differences compared. Bonferroni correction (any $n>2$) would lead the results discussed in this section to not be significant.

4.3.4.4 Reaction time: main effects

Models (Table 4.13) examining main effects of experimental conditions and individual differences on reaction time found no effect of experimental conditions on reaction time. However, there was a significant effect of NFC and a marginal trend of the sacredness subscale of cultural attachment. Participants with higher need for cognitive closure reacted slower than participants with lower need for cognitive closure (b_{NFC} = 0.014, SE = 0.006, p = 0.03). Participants who think of their culture as being more sacred reacted marginally faster than participants who do not (b_{CAsacred} = -0.02, SE = 0.01, p = 0.06). There were no significant interaction effects of experimental conditions and individual differences on reaction time.

Table 4.8: Linear mixed effects models of ISCR

(Main effects of experimental conditions w controls)

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.053***	.046***	.047***	.056***
	(.005)	(.005)	(.005)	(.011)
Threat		.008*		
		(.004)		
Secure Base			.003	
			(.004)	
log(RT)				−.020
				(.024)
Observations	1,259	1,259	1,259	1,259
Log Likelihood	1,745.893	1,751.862	1,748.507	1,750.035
Akaike Inf. Crit.	−3,481.787	−3,479.725	−3,473.015	−3,476.070
Bayesian Inf. Crit.	−3,456.096	−3,418.068	−3,411.358	−3,414.413

Standard errors are in parentheses. *$p<0.1$; **$p<0.05$; ***$p<0.01$

Models (1) to (4) are in the form of: ISCR $\sim$ IV + (IV|Participant/Block) + (log(Onset Time)|Participant) where IV(1)=1; IV(2)=Threat; IV(3)=Secure Base; IV(4)=log(Reaction Time).

Table 4.9: Linear mixed effects models of ISCR (Main effects of individual differences w controls I)

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.047***	.048***	.048***	.048***
	(.005)	(.005)	(.005)	(.005)
CA-Security	−.001			
	(.002)			
CA-Insignificance		.0001		
		(.002)		
CA-Boundarylessness			−.002	
			(.001)	
CA-Sacredness				−.001
				(.002)
Observations	1,259	1,259	1,259	1,259
Log Likelihood	1,749.125	1,747.578	1,750.213	1,749.561
Akaike Inf. Crit.	−3,474.249	−3,471.157	−3,476.427	−3,475.122
Bayesian Inf. Crit.	−3,412.593	−3,409.500	−3,414.770	−3,413.465

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
Models (1) to (4) are in the form of: ISCR $\sim$ IV + (IV|Participant/Block) + (log(Onset Time)|Participant) where IV(1)=CA–Security; IV(2)=CA–Insignificance; IV(3)=CA–Boundarylessness; IV(4)=CA–Sacredness.

Table 4.10: Linear mixed effects models of ISCR (Main effects of individual differences w controls II)

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.046***	.048***	.048***	.049***
	(.008)	(.005)	(.005)	(.005)
Sex	.004			
	(.010)			
NFC		−.014		
		(.010)		
Patriotism			.0004	
			(.001)	
Racial Essentialism				−.008
				(.009)
Observations	1,259	1,259	1,259	1,259
Log Likelihood	1,750.198	1,752.018	1,746.934	1,753.104
Akaike Inf. Crit.	−3,476.395	−3,480.036	−3,469.868	−3,482.207
Bayesian Inf. Crit.	−3,414.738	−3,418.379	−3,408.212	−3,420.550

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01

Models (1) to (4) are in the form of: ISCR $\sim$ IV + (IV|Participant/Block) + (log(Onset Time)|Participant) where IV(1)=Sex; IV(2)=Need for Cognitive Closure; IV(3)=Patriotism; IV(4)=Racial Essentialism.

Table 4.11: Linear mixed effects models of ISCR (Main effects of individual differences w controls III)

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.050***	.047***	.050***	.048***
	(.005)	(.005)	(.005)	(.005)
Paternal Care	.001			
	(.001)			
Paternal Overprotect		.0002		
		(.001)		
Maternal Care			.001	
			(.001)	
Maternal Overprotect				.0001
				(.001)
Observations	1,259	1,259	1,259	1,259
Log Likelihood	1,748.102	1,747.318	1,747.817	1,746.642
Akaike Inf. Crit.	−3,472.203	−3,470.635	−3,471.634	−3,469.285
Bayesian Inf. Crit.	−3,410.546	−3,408.979	−3,409.977	−3,407.628

Standard errors are in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Models (1) to (4) are in the form of: ISCR $\sim$ IV + (IV|Participant/Block) + (log(Onset Time)|Participant) where IV(1)=Paternal Care; IV(2)=Paternal Overprotection; IV(3)=Maternal Care; IV(4)=Maternal Overprotection.

Table 4.12: Linear mixed effects models of ISCR (Main effects of individual differences w controls IV)

	Dependent variable:		
	Integrated Skin Conductance Response		
	(1)	(2)	(3)
Intercept	.049***	.045***	.049***
	(.005)	(.004)	(.005)
Positive Affect	.008		
	(.006)		
Negative Affect		$-$.016*	
		(.008)	
Familiarity			.001
			(.001)
Observations	1,259	1,259	1,259
Log Likelihood	1,751.069	1,752.521	1747.419
Akaike Inf. Crit.	$-$3,478.138	$-$3,481.041	$-$3,471.035
Bayesian Inf. Crit.	$-$3,416.481	$-$3,419.384	$-$3,405.913

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01

Models (1) to (4) are in the form of: ISCR $\sim$ IV + (IV|Participant/Block) + (log(Onset Time)|Participant) where IV(1)=Positive Affect; IV(2)=Negative Affect; IV(3) = Familiarity.

Table 4.13: Linear mixed effects models of Reaction Time (Main Effects)

	Dependent variable:	
	Reaction Time	
	(1)	(2)
Intercept	.389***	.389***
	(.005)	(.005)
NFC	.015**	
	(.006)	
CA-Sacredness		.002*
		(.001)
Observations	1,259	1,259
Log Likelihood	1,566.065	1,563.934
Akaike Inf. Crit.	−3,114.129	−3,109.869
Bayesian Inf. Crit.	−3,067.887	−3,063.626

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01

Models (1) to (4) are in the form of: log(RT) $\sim$ IV + (IV|Participant/Block) + (log(Onset Time) |Participant) where IV(1)=Need for Cognitive Closure; IV(2)=CA–Sacredness.

4.4 Discussion

The main finding of this study is that the subliminal display of cultural symbols reduces bodily responses associated with threatening stimuli (H1). The individual's need for cognitive closure (H5) and the perceived insignificance of their role/place in their culture (H2b) moderated the effectiveness of these cultural symbols. Additionally, individuals with higher NFC, a measure of an individual's need for firm answers and aversion of ambiguity, had slower reaction times. Taken together, these results suggest that cultural attachment, cultural symbols, and culture serve to reduce uncertainty in the world but are more effective for some more so than for others. Individuals produced higher SCR when under threat. However, they were able to rely on their cultural symbols for security to regulate their emotions. Similar to previous studies (Hong et al., 2013; Mikulincer et al., 2001b), the symbolic representation of a secure base mitigates negative emotions experienced by the individual. This is further discussed in the final chapter of this thesis.

In turn, NFC helps with our understanding of which individuals would find such cultural secure bases to be more effective. NFC measures individual's need for epistemic security (Kruglanski and Webster, 1996) and is thought to be a fairly stable influence on his/her view of the social world (Roets et al., 2015). In this study, NFC appears to influence the effectiveness of cultural icons at mitigating the stress responses associated with threats. This suggests that individuals with higher NFC might rely more (as compared to individuals with low NFC) on cultural symbols for security. This is in line with prior literature which suggests that NFC is linked to in-group favouritism, reliance and centralism (Kruglanski et al., 2006; Federico et al., 2005; Chao et al., 2007). Additionally, higher NFC has been associated with higher adherence to cultural norms when making attributions - this result held true for both Hong-Kong Chinese and US participants (Chiu et al., 2000). In other studies, higher levels of NFC were also linked to higher levels of disgust towards images where icons of two different cultures are fused (Cheon et al., 2016) and a preference for mono-cultural societies over culturally fused ones (De Keersmaecker et al., 2016); additionally higher NFC impedes the acceptance of cultural mixing in the workplace (Fu et al., 2015) and hampers creativity (Chen et al., 2016). All in all, individuals with higher NFC place more emphasis on maintaining the status quo with the representation and features of their culture.

A previous study examining NFC differences between adults with different attachment styles (Mikulincer, 1997) reported that insecurely attached individuals also scored higher on NFC, especially in subscales relating to ambiguity and uncertainty. Similarly, individuals who score higher on anxious attachment also have a higher NFC and are more likely to be religious (Saroglou et al., 2003). Following from that and the suggestion that caregivers act as surrogate prefrontal cortices (Gee et al., 2013b), aiding in decision making as well as emotion regulation for young children, there is a possibility that culture serves a similar function when primary caregivers leave a void. The negative correlation between the security aspect of cultural attachment and levels of maternal care suggest that individuals might rely on culture when their expectations of care are not met. It might be worth exploring if there is a baseline level of social emotion regulation that individuals require and also whether there are different attachment targets that can fill that need.

In comparison to NFC, the idea of cultural insignificance is more nascent and understudied. Cultural insignificance measures the individual's perception of the importance of their role or place in their culture. In this study, the effectiveness of cultural symbols at mitigating stress responses was tied to the perceived relative importance felt by the individual in their culture. Surprisingly, individuals who felt more important in their culture had less success in relying on their culture for security. A possible explanation would be that individuals would not need to rely on culture or cultural groups that are not much more powerful than themselves. This is partly supported by the literature on leadership. For example, in times of crisis, followers are more likely to follow leaders who are perceived to be much stronger and wiser; whereas there is no crisis, individuals are said to rely on different social institutions for support and guidance and the role of the leader is less significant (Mayseless and Popper, 2007). There is insufficient depth in the current study to examine the mechanisms of the moderation but looking at differences in perceived power and ability might be a good starting point.

An important limitation of the study is the partially ambiguous nature of SCR. SCR have been posited to be a general arousal response or an attention/stress response. The former implies that SCR do not depend on the valence of the stimuli whereas the latter implies that SCR discriminate between positive and negative stimuli. The interpretation of the experimental paradigm changes depending on which model of SCR is used. Previous research suggested that SCR are valence-independent and increase with arousal (Anders et al., 2004). However, other researchers have suggested more complex interpretations of the SCR signal. Emotionally-laden paradigms are said to include limbic structures which generates inhibitory and excitatory responses depending on the demands and assessment of the situation (Boucsein, 2012). In addition, negative stimuli seem to get priority in time and discriminability (Fox et al., 2007; Milders et al., 2006). As such, it has been recommended that SCR data be collected together with other types of data in order to get a comprehensive picture.

In conclusion, this study provided initial biological evidence that cultural symbols affect emotion regulation and threat processing. This small but important step justifies further exploration of the inner workings of cultural attachment. The next study will employ fMRI to examine neural responses during the emotion regulation process in a bid to uncover more precise mechanisms of cultural attachment. In addition, the lack of significant contribution from the parental attachment measures (H3 and H4) suggests that other methods of comparing parental and cultural attachment should be used.

Chapter 5

Study 2

The focus of Study 1 was to examine the effect of cultural attachment on the body's stress responses when individuals are threatened. Cultural symbols were shown to act as effective secure bases in regulating the negative emotions (as approximated by sympathetic responses) experienced from threats presented. This supports the suggestion that culture can act as a valid attachment target. Furthermore, need for cognitive closure and the insignificance subscale of cultural attachment were shown to modulate the effectiveness of these cultural symbols.

In Study 2, a similar experimental paradigm is used to examine the generalizability of the results in Study 1. In prior experiments, the effects of cultural attachment were typically found in expatriates who grew up in one country but moved to another country for work or studies (Hong et al., 2013). Although the results in Study 1 suggest that similar effects can be found in locals who are sensitive to threats, it is prudent to test our hypotheses on groups of participants with different demographic backgrounds. Chinese expatriates who were working or studying in the US and a matched group of Americans were recruited. As described in chapter 3, corresponding changes to the cultural symbols were made. To reiterate, the home cultural symbols were represented by Chinese symbols for the Chinese participants and American symbols for the American participants. The American symbols were then introduced as host/foreign cultural symbols for the Chinese participants and similarly, the Chinese as host/foreign cultural symbols for American participants.

Additionally, following from the proposed systems in chapter 2.4, the possible effects of cognitive control on emotion regulation remain untested. SCR are unsuitable for examining higher order processes in the brain as those processes might take place without any manifestation in the peripheral nervous system. As such, fMRI is introduced in Study 2 to examine both emotion regulation and cognitive control. Not only does fMRI identify areas of activation in the brain accurately, its non-invasive nature makes it safer and easier to operate than other methods used in measuring brain activity. As a result, a wider range of participants can be recruited.

In the conceptual model (Fig 2.2), several brain regions were posited to be involved in the entire process where individuals leverage on cultural symbols to mitigate threat responses. Although the study takes an exploratory whole brain approach and does not restrict search parameters to specific regions in the brain, more attention is paid to the regions identified in the model. As such, the following are some hypotheses about differences in activations in these regions due to cultural attachment. The first hypothesis is a trivial one positing that the presence of cultural symbols when individuals are under threat will lead to differences in neural activations.

H1: There is at least an area in the brain where the increase in activations when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

Affective regions (such as amygdala and insula) are involved in threat processing so these areas are expected to activate differentially when individuals are presented with threats as compared to non-threats. These regions, after receiving inputs from emotion regulation regions, are also responsible for signalling other regions (e.g. hypothalamus, motor regions) to make adequate responses. If threats are successfully mitigated by emotion regulation regions, affective regions are less likely to be recruited since a response is probably not needed. As such, the following hypothesis is made.

H2: The increase in activations of affective regions (e.g. amygdala, insula) when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

The regions of the brain relating to emotion regulation are also expected to activate differentially to threat when in the presence of cultural symbols. After validating that threat is present, emotion regulation regions are recruited to mitigate the threat. This leads to the next hypothesis.

H3: The increase in activations of emotion regulation regions (e.g. DLPFC) when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

Results indicating differences in other brain regions will be further elaborated upon in the discussion section. Additionally, correlations with any individual differences were also reported in the results section but due to the nascent nature of related neural activations, any significant results are elaborated upon in the discussion section.

Although the focus of study 2 is on locating neural activations relating to CA, three behavioral responses were also measured as additional dependent variables. Similar to Study 1, the participant's reaction time in indicating the direction of the arrow was measured. The other two behavioral measures are related to an addition to the experimental paradigm based on the principles of affective transfer. Following the indication of the arrow, participants were also asked to rate the likeability of a random pattern that appeared. The participant's reaction time in providing this rating was also measured. Affective transfer suggests that the rating of the random pattern is expected to be more negative when the participant experiences threat. If the threat is mitigated, the rating would correspondingly be more positive. Similar to Cloitre and colleagues (1992), the reaction time of participants in trials where they were threatened but unable to mitigate the threat is expected to be higher (i.e. they are slower) than if they successfully mitigated the threat. This leads to the following hypotheses.

H4a: The decrease in likeability ratings when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

H4b: The increase in the time taken to indicate the direction of the arrow when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

H4c: The increase in the time taken to provide the likeability rating when individuals are exposed to threat is lower when individuals are also subliminally presented with cultural symbols (in comparison to neural acultural symbols).

Similar to study 1, there are individual differences (see chapter 2.3.1) that are expected to moderate the behavioral responses of individuals. Together with the possible confounds, they form the following hypotheses.

H5a: NFC moderates the decrease in H4a such that individuals with higher NFC will experience a smaller decrease than individuals with lower NFC.

H5b: NFC moderates the increase in H4b such that individuals with higher NFC will experience a smaller increase than individuals with lower NFC.

H5c: NFC moderates the increase in H4c such that individuals with higher NFC will experience a smaller increase than individuals with lower NFC.

H6a: Racial essentialism moderates the decrease in H4a such that individuals who hold more essentialist beliefs will experience a larger decrease than individuals who hold more constructionist beliefs.

H6b: Racial essentialism moderates the increase in H4b such that individuals who hold more essentialist beliefs will experience a larger increase than individuals who hold more constructionist beliefs.

H6c: Racial essentialism moderates the increase in H4c such that individuals who hold more essentialist beliefs will experience a larger increase than individuals who hold more constructionist beliefs.

H7a: The lowered decrease described in H4a is not moderated by the following confounding variables, i) patriotism; ii) positive affect; iii) negative affect; iv) familiarity; v) group identity (cultural identification); vi) perceived racism; vii) acculturation stress.

H7b: The lowered increase described in H4b is not moderated by the following confounding variables, i) patriotism; ii) positive affect; iii) negative affect; iv) familiarity; v) group identity (cultural identification); vi) perceived racism; vii) acculturation stress.

H7c: The lowered increase described in H4c is not moderated by the following confounding variables, i) patriotism; ii) positive affect; iii) negative affect; iv) familiarity; v) group identity (cultural identification); vi) perceived racism; vii) acculturation stress.

5.1 Materials and Methods

This study was approved by the institutional review boards of Nanyang Technological University and Virginia Tech Carillion Research Institute.

5.1.1 Participants

Chinese nationals living in the US and American citizens were recruited using online and physical advertisements in Virginia, USA. Chinese participants were recruited before American participants so that the demographic profile of both groups could be as similar as possible. Interested participants were informed about the details of the experiment through a phone call. Participants who remained interested were asked for their demographic information including their medical and cultural history (see the appendix for an example of the phone screening protocol). Participants who had pre-existing or prior histories of neurological or psychiatric illnesses, lived in a country other than their home or host country (China or USA) for longer than six months were excluded from the study. The remaining participants (Chinese: n = 30; 13 females; M_{age} = 23.2; sd = 2.90; American: n = 31; 14 females; M_{age} = 22.68; sd = 4.76) were invited to the laboratory for two separate sessions. 5 Chinese and 4 US participants were subsequently excluded from data analysis due to excessive head movement. Data from the remaining participants (Chinese: n = 25; 11 females; M_{age} = 23.2; sd = 2.98; American: n = 27; 11 females; M_{age} = 23.1; sd = 4.92) is the data used for all analyses used in this section. Participants were paid USD 10 for completing the questionnaire portion and USD 50 for completing the brain scan.

5.1.2 Experimental Procedure

In the first session, participants provided their written consent then completed a questionnaire consisting of the cultural attachment (dimensional) scale (Hong et al., 2013), cultural identification scale (Hong et al., 2013), experiences in close relationships scale (Brennan et al., 1998), perceived racism scale, need for cognitive closure scale (Roets and Van Hiel, 2011a; Webster and Kruglanski, 1997), racial essentialism scale (No et al., 2008), and patriotism scale (Huddy and Khatib, 2007; Kosterman and Feshbach, 1989). In the second session, participants first completed a self-reported mood check (PANAS; Watson et al., 1988) outside the scanner. After both sessions, participants completed the affective priming task with their brain activity recorded in an fMRI scanner.

Participants were allowed to complete 20 practice trials before the task to familiarise themselves with the button box input and screen setup in the scanner. Participants were allowed to repeat the practice trials if they felt a need to. Each participant then completed 192 trials from 8 experimental conditions (2: Threat/Non-Threat x 4: US/Chinese/Maternal/Control) with the trials presented in a fully randomised order. Figure 5.1 (pg119) contains a summary of one trial in the task. At the start of each trial, a fixation cross appeared on the screen for 1000 ms with a random jitter of mean 500 ms and capped at 5000 ms. Random jitters were used in the experiment to reduce anticipation from the participant (Foxe et al., 2012). Following that, a threat or non-threat image was displayed for 200 ms. Unlike Study 1, threat or non-threat images were presented in full colour here. An arrow, randomly chosen to point either to the left or the right in each trial, was also presented in the middle of the screen. A secure base image was then subliminally displayed for 17 ms before the same threat or non-threat image appears for another 283ms. Two options ("Left" and "Right") appeared on the screen. Participants had 700 ms to indicate the direction of the arrow via a button press. Participants were instructed to answer as quickly as they could. The time participants took to make their choice was recorded as their reaction time to the arrow. The choice made by participants was highlighted in red for 500 ms. If participants failed to make a choice, an error screen appeared for 500 ms. Feedback about the correctness of their choices were not given during the task. Following that, an image with randomly spread out geometric shapes appeared on the screen for 1000 ms with a random jitter of mean 1000 ms and capped at 5000 ms. Participants were then asked to rate the image for likeability with three options appearing on the screen (1 = negative, 2 = neutral, 3 = positive). The order of the likeability options were the same for all trials but counterbalanced between different participants. Participants were given 5000 ms to respond. The time participants took to make their choice was recorded as their reaction time to the likeability question. The option chosen by participants was highlighted in red for 500 ms. If participants failed to make a choice, an error screen appeared for 500 ms. Stimuli was presented on the computer monitor (with refresh rate of 60 Hz) using the Psychtoolbox package (Brainard and Vision, 1997; Kleiner et al., 2007; Pelli, 1997) in Matlab (Mathworks). Psychtoolbox has been

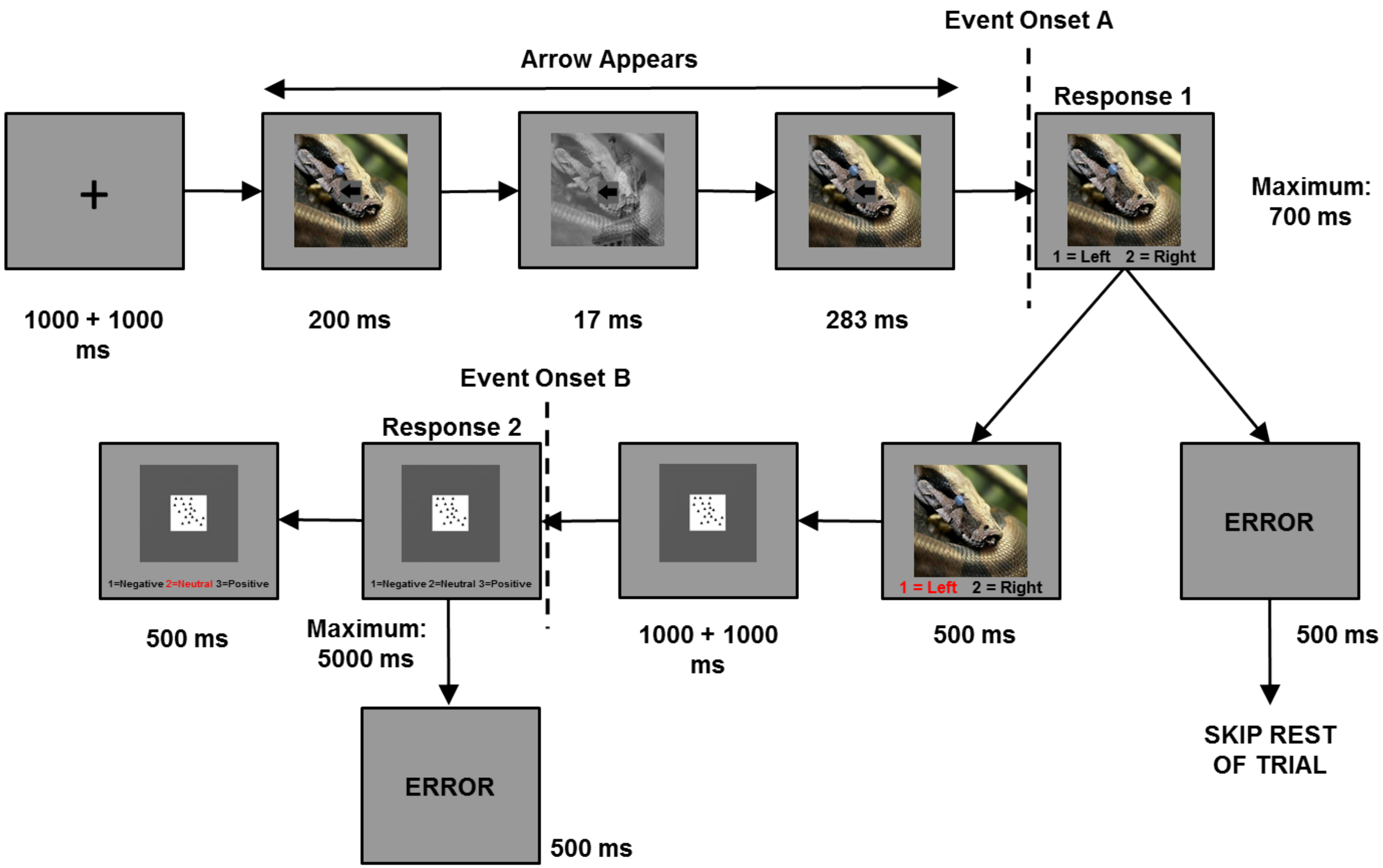

Figure 5.1: Example trial where a threatening image (snake) is followed by a subliminally presented host culture symbol (Statue of Liberty) which is overlaid with the threatening image with both images set at 50% transparency. Participants had to indicate the direction of the overlaid arrow (Response 1). Following feedback, a random geometric pattern was presented. Participants rated the pattern in terms of likeability (Response 2). Event onsets A and B are labelled to indicate the onset timing used in the fMRI analysis.

previously used in experiments with subliminal presentation (Zebrowitz et al., 2008).

5.1.3 Materials

Images used in this study were pre-tested in Pre-Study 1 (see Chapter 3). Five of the most representative images were chosen for each of the experimental conditions (Threat, Non-Threat, American, Chinese, Maternal, and Control). From above, there are 8 conditions (2 by 4) in each experiment of 24 trials each. Unlike in study 1, the images were not presented in blocks based on their conditions. Instead, the order of presentation of the images was entirely randomised for each participant. In each trial, either a threatening or non-threatening image was presented before and after a secure base image (American, Chinese, Maternal, and Control). As such, threatening and non-threatening images were presented 19 or 20 times per experiment while secure base images were presented 9 or 10 times per experiment. Additionally, the computer ensured that conditions were not repeated more than once in succession.

5.1.4 Post Experiment Survey

After completing the task, participants completed a rating survey outside of the scanner where they were required to rate the stimuli shown to them. Secure base images (American, Chinese, Maternal, and Control) were rated based on three criteria of how 1) American, 2) Chinese, 3) attractive, and 4) connected to you, the image is. Threat/non-threat images were rated based on two criteria of how 1) threatening, and 2) familiar, the image is.

5.1.5 fMRI Imaging Parameters

Brain images were acquired using a 3.0 Tesla Siemens TIM Trio MRI scanner. The first three scans were discarded to allow for stabilization. Functional images were collected with the following parameters: echo-planar imaging, gradient recalled echo; repetition time (TR) = 2s; echo time (TE) = 30 ms; flip angle = 90 degrees; 4mm slice thickness; resulting in voxels 3.2 x 3.2 x 3.2 mm, acquired at 30 degrees from the anterior commissure - posterior commissure (AC-PC) line. Structural images were collected with the following parameters: high resolution prepared rapid acquisition, gradient echo sequence; TR = 1200 ms; TE = 2.66 ms; 1 mm slice thickness; 192 slices with spatial resolution of 1 x 1 x 1 mm.

5.2 Statistical Analysis

Data analysis was split into two main portions - the behavioural DVs and the fMRI data. In the first section, statistical analyses of the behavioural components in Study 2 were performed using linear mixed effects models similar to those used in Study 1. Following that, whole brain and ROI analyses of the neural data were performed. Whole brain results were also regressed with various individual differences. All analyses were performed on each participant group (Chinese and American) as well as the combined group. Tables were created using the stargazer package (Hlavac, 2014) in R. Graphs were created using ggplot2 (Wickham, 2016) and ggpubr (Kassambara, 2017) packages in R.

5.2.1 Behavioral DVs

Three dependent variables were included in the analysis: reaction time to the arrow question, reaction time to the likeability question, and ratings in the likeability question. Trials in which participants could not correctly identify the direction of the arrow were excluded from all analyses. In the previous study, onset time of the stimulus significantly affected SCR but not reaction time. Due to the completely randomised order of trials rather than the usage of randomised blocks, the same effect is not expected in this study.

Multiple responses were collected from each participant in different conditions over the course of the experiment. In order to correctly account for the nested structure and control for the non-independence, linear mixed effects models were used to analyse the data (Hox, 2002; Raudenbush and Bryk, 2002). All analyses performed included participants as a grouping variable. The models used were random slope and random intercept models to account for as much idiosyncratic variation as possible. The parameter estimates were obtained using the restricted maximum likelihood (REML) estimation method which produces relatively unbiased estimates (Harville, 1977). However, the Akaike information criterion (AIC) and log-likelihood values can only be obtained by using the same models with the maximum likelihood (ML) estimation method.

Data analyses were completed in R (R Core Team, 2011/2), using the lme4 package (Bates et al., 2014). Reaction times were log-transformed using y = log (1+x) to standardize the positively skewed distributions before any further analysis. All questionnaire and reaction time measures were centralised as well to improve convergence during the maximum likelihood estimation. The Kenward-Roger approximation for degrees of freedom was used in obtaining p-values by using the pbkrtest package in R (Halekoh and Hojsgaard, 2012). Variance inflation factor (VIF) calculations were made using recommendations from the works of (Nakagawa and Schielzeth, 2013).

5.2.2 fMRI Preprocessing

Raw fMRI data tends to be noisy due to several factors, such as head movement, noise from the scanner and the environment. A number of preprocessing measures were used to reduce the noise in the data. Before preprocessing the data, the first three volumes for each session were removed to allow for T1-equilibration effects. SPM 12 (Wellcome Trust Centre for Neuroimaging, www.fil.ion.ucl.ac.uk/spm12), a package in Matlab (Mathworks), was used in the preprocessing and statistical analysis of the fMRI data in this thesis.

First, the images were ensured to be centred. This is done by making sure the origin of each image was set to match the line joining the anterior-commissure to the posterior-commissure line (AC-PC line). Uncorrected head motion in the images will introduce noise to the data and possibly lead to wrong conclusions. To correct for any head motion, the images were realigned to match a reference frame using rigid-body affine transformation. The three translation and three rotation parameters about the orthogonal axes (x,y,z) were obtained and included as nuisance regressors in the statistical analyses.

Previously, participants with excessive head motion ($>$3mm translation or 3 degrees rotation) were removed from the analysis entirely. However, with the introduction of the artifact repair script (ArtRepair.m; Mazaika et al., 2005, 2007, 2009) package, individual scans were repaired by interpolating data from adjacent scans. This allowed participants who made a few sudden motions or a slow constant motion to be retained in the analysis and for their data to be better aligned to the reference frame. Temporal interpolation of data can lead to disruption of the temporal correlation of the signal (Power et al., 2017; Caballero-Gaudes and Reynolds, 2017). If applied excessively or in an unbalanced manner across different groups being tested, methods like Artrepair will bias the results. In order to combat these problems, the analysis in this study follows several recommendations made (Power et al., 2017; Caballero-Gaudes and Reynolds, 2017) such as performing the head motion estimation prior to the realignment of the data, limiting the number of repairs to 5 (the authors do not mention an explicit guideline but recommend a low and balanced number), and the movement parameters were included as nuisance regressors in the statistical analyses. Unfortunately, the data from 5 Chinese and 4 American participants was not able to be properly repaired which led them to still be removed from the analysis.

Following the artifact repair, images were spatially normalized to a standardized space to allow for between-group analyses. At the same time, results across different studies can be interpreted meaningfully. The images of each American and Asian participant in this thesis were geometrically distorted to fit into the European and East-Asian Montreal Neurological Institute (MNI) spaces respectively. Specifically, the mean image of the realigned T2*-weighted functional images from each participant was coregistered with their T1-weighted structural image. Then, each participant's T1-weighted structural image was segmented into grey and white matter and mapped onto template tissue probability maps. Tissue probability maps define the probability to locate different tissue types (white matter, grey matter, cerebrospinal fluid, bone, air/background) in different regions of the brain. Spatially normalized images are obtained by applying the mapping to the original structural and realigned functional images.

Finally, the realigned normalized images were smoothed by applying a Gaussian kernel of 6mm full width half maximum (FWHM; Worsley et al., 1996; Ashburner and Friston, 1999). This smoothing process improves the validity of the statistical inferences by ensuring that the errors are more normally distributed. It also ensures that the data fulfills the assumptions for random field theory which is used to correct for the multiple statistical comparisons (discussed in the next section).

5.2.3 First-level GLM (participant-level)

In order to model the effects specific to the desired regressors, two event onsets were chosen. The first onset coincides with the arrow options being shown and the second onset coincides with the likeability options being shown (Figure 5.1, pg119). As a result, two separate delta functions were selected to model these separate event onsets in each trial. These delta functions were convolved with canonical HRFs to estimate BOLD activity at the different time points. Analyses conducted only compared neural activity between conditions in each event onset (either arrow or likeability) but never across both event onsets. Specifically, different linear combinations of the various regressors were used to examine differences in neural activations in different conditions. The common notation, A $>$B, is used to represent the comparison of areas in the brain that are more activated in condition A over condition B. It is important to note that results produced by A $>$B and B $>$A produce different results and are not complementary so both analyses are required. Lastly, movement parameters obtained from realignment corrections were included as parametric modulators to account for spurious results due to incidental head movement.

5.2.4 Second-level GLM (group level): Whole Brain Analysis

The contrast estimates obtained from each first level GLM were entered into separate second level GLM where the one sample t-test statistic (with null hypothesis T=0) for each voxel was reported in the SPM produced. Whole brain analyses were used to examine neural correlates of responses towards threat, responses towards different secure base images, the interacting effect between the presence of threat and type of secure base image shown. A gray matter mask, determined using WFU pick atlas toolbox (Maldjian et al., 2003) with aal mapping (Tzourio-Mazoyer et al., 2002) and dilation = 2, is introduced to only include sections of the brain containing gray matter. Similar to using an ROI, the removal of areas containing white matter and their associated errors produces clearer results with less false negatives. Brain areas with significantly different activations were identified with thresholds of pFWE $<$0.05. Following recommendations to employ less stringent correction measures (Liberman, 2009), a voxel-wise and cluster-wise threshold of uncorrected $p < 0.001$, and cluster size, $k > 10$, was used. However, in order to identify activations which were more robust, a stricter family-wise error corrected voxel-wise threshold of pFWE < 0.05 was used as well. This is in line with up-to-date statistical recommendations (Woo et al., 2014; Yeung, 2018).

5.2.5 Second-level GLM: Multiple Regressions

Individual difference measures were regressed with each voxels to identify moderated neural activations. These multiple regressions were performed at the whole brain level with the abovementioned gray matter mask. Brain areas with significantly different activations were identified with thresholds of $p_{FWE} < 0.05$.

5.2.6 Second-level GLM: ROI Analysis

ROI analyses are performed by identifying a-priori selected brain regions using the WFUpickatlas tool (Maldjian et al., 2003). The different ways used to define ROI regions in this thesis are by relying on previous definitions in the Automated Anatomical Labeling (AAL; Tzourio-Mazoyer et al., 2002), or relying on Talairach Daemon database labels (TD; Talairach and Tournoux, 1988), or by defining a sphere centred on a peak voxel established in prior literature. The AAL and TD databases are two different databases with slightly different segmentation and labelling of brain regions. Each of these databases has unique strengths in their segmentation which allow for more adequate examination of a certain region of interest. These databases are useful in identifying small, specific regions of interest and to identify general regions of the brain where there is insufficient prior literature to rely on. However, in order to locate brain activations in a specific subset of voxels in a bigger brain region, a sphere centred on a previously located peak voxel can be used. The average BOLD response in the defined area was extracted for each participant and tested using a one sample t-test. Areas are considered to have significantly different activations when $p < 0.05$.

Regions of interest were selected based on literature reviewed in chapter 2.4. Although there is no establish model of cultural attachment, many of these areas are implicated in attachment-related behaviours. The ROIs selected (see Figure 5.2) using the AAL atlas were the amygdala, the insula, the hippocampus, the thalamus, the pallidum, and the angular gyri. The substantia nigra was selected based on the TD labels.

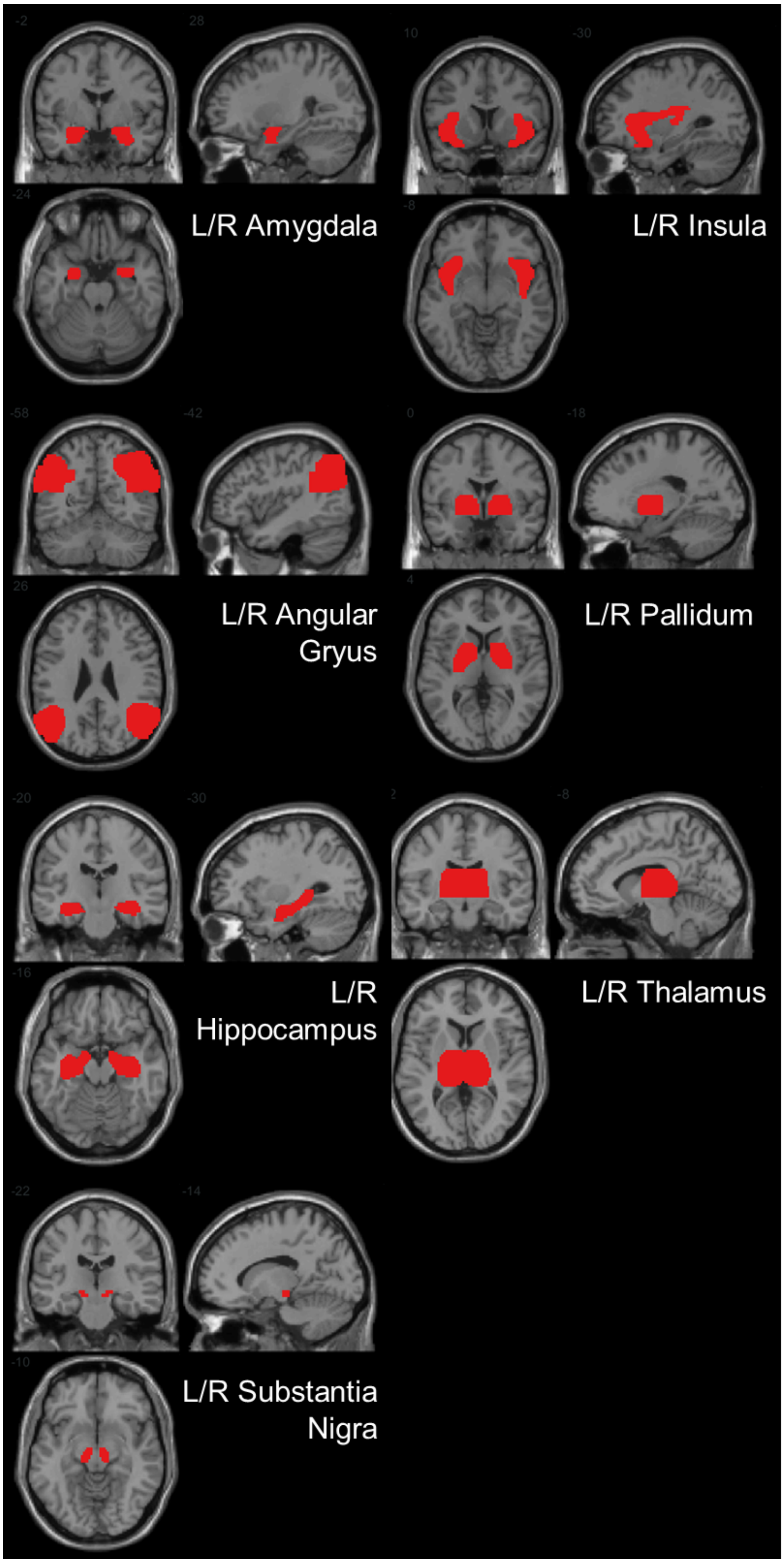

Figure 5.2: The ROI masks used in Study 2.

5.3 Results

Before showing the results of the hypotheses testing, the descriptive summaries for the post-experiment image ratings and questionnaire measures are shown. The questionnaire measures are included as moderators in both the behavioral and neural models so their nature is first established. Subsequently, the behavioral models are shown followed by the neural models.

5.3.1 Post-experiment Image Ratings (Manipulation Check)

Post experiment image ratings from the combined sample (see Figure 5.3, pg130) were used to ensure that the images shown were from their assigned category. The ratings were in tandem with their expected category: threatening images received higher ratings than non-threatening ones in the related question (MThreat = 3.021, sd = 1.067; $M_{\text{Non-Threat}}$ = 1.175, sd = .326; $t(51)$ = 12.83, p <0.001). Chinese (M_{Chinese} = 4.791, sd = .399) secure base images were rated as more "Chinese" than American (M_{American} = 1.446, sd =.712; $t(57)$ = 26.45, p <0.001), maternal (M_{Maternal} = 3.381, sd = .823; $t(57)$ = 12.65, p <0.001), and control (M_{Control} = 2.683, sd = 1.058; $t(57)$ = 14.06, p <0.001) images. Similarly, American (M_{American} = 4.791, sd = .316) secure base images were rated as more "American" than Chinese (M_{Chinese} = 1.420, sd = .609; $t(57)$ = 32.50, p <0.001), maternal (M_{Maternal} = 3.065, sd = .814; $t(57)$ = 14.31, p <0.001), and control (M_{Control} = 3.080, sd = 1.054; $t(57)$ = 11.96, p <0.001) images.

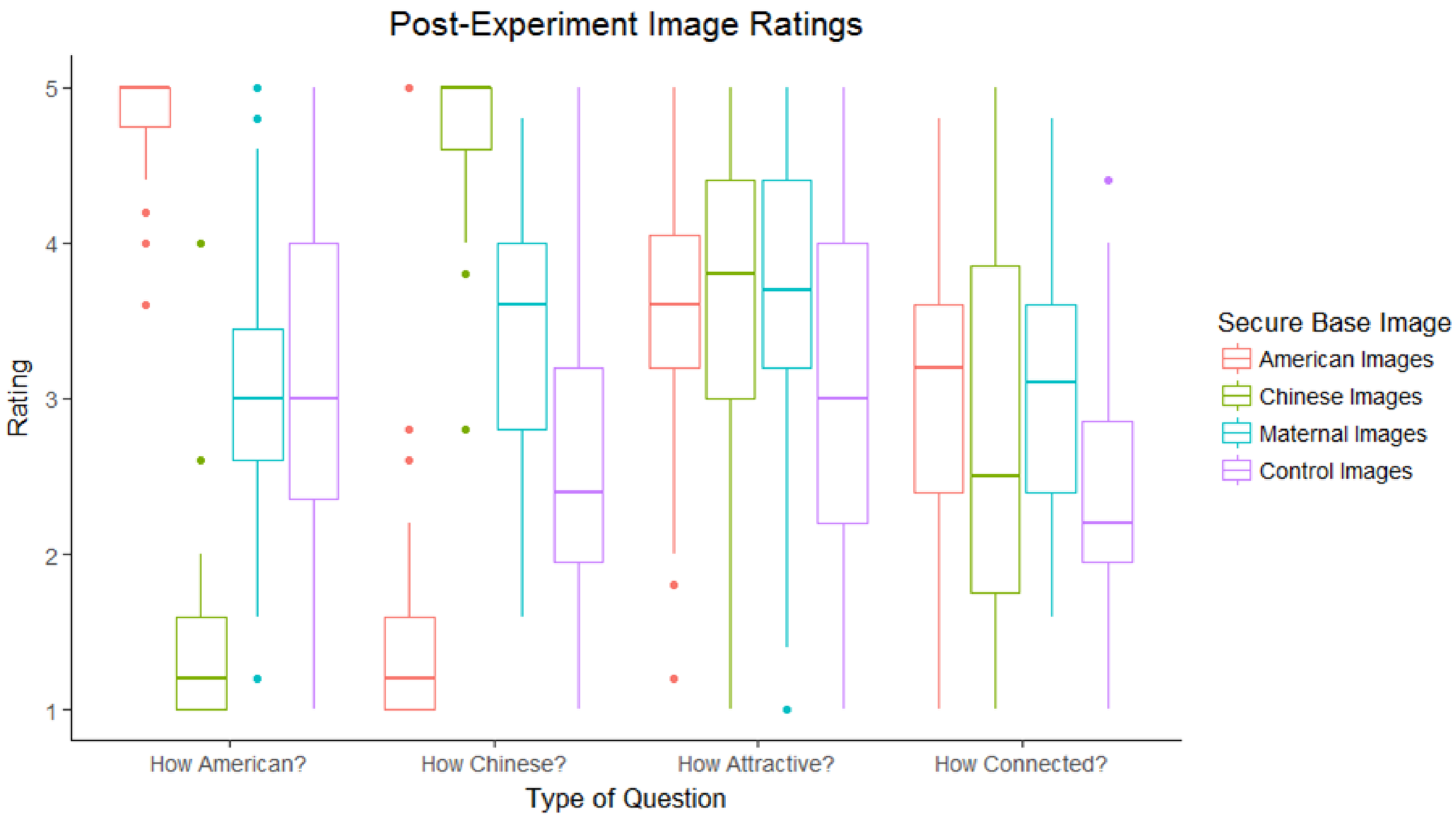

Figure 5.3: Summary of post-experimental image ratings from the combined sample in Study 2.

Table 5.1: Descriptive Statistics of Individual Differences

	Combined (N=52)		Chinese (N=25)		American (N=27)		
	Mean	SD	Mean	SD	Mean	SD	*p*
ECR (Anxiety)	2.806	0.769	2.869	0.740	2.747	0.804	0.570
ECR (Avoidance)	2.382	0.700	2.466	0.627	2.305	0.765	0.407
CHI CA (Anxiety)	2.162	0.667	2.188	0.648	2.137	0.696	0.786
CHI CA (Avoidance)	2.512	0.605	2.272	0.404	2.734	0.679	0.004
US CA (Anxiety)	2.262	0.654	2.476	0.715	2.063	0.532	0.023
US CA (Avoidance)	2.460	0.622	2.784	0.500	2.159	0.578	0.000
CHI CI	4.247	1.322	5.326	0.549	3.249	0.998	0.000
US CI	5.129	0.738	4.960	0.673	5.286	0.772	0.111
Need For Closure	3.826	0.758	3.731	0.713	3.914	0.801	0.388
Racial Essentialism	3.389	0.859	3.615	0.879	3.181	0.801	0.069
Patriotism	4.990	1.114	5.290	0.879	4.713	1.247	0.058
Perceived Racism	1.376	0.294	1.406	0.288	1.349	0.302	0.493
Self-Reported Stress	3.062	0.138	3.109	0.115	3.018	0.146	0.014

Note: ECR = Experiences in Close Relationships (Adult Attachment), CA = Cultural Attachment, CI = Cultural Identification.

p values are for t-test comparisons between the Chinese and American sample.

5.3.2 Questionnaire Measures

The results from the analysis of the questionnaire measures are reported in this section. Table 5.1 contains the descriptive statistics of the questionnaire measures of the combined sample, Chinese sample, and American sample respectively. Participants did not register unusually high positive (M_{positive} = 2.625; sd = 0.539) or negative (M_{negative} = 2.044; sd = 0.527) emotions prior to the experiment. Differences between the Chinese and American samples are highlighted in the paragraphs below.

5.3.2.1 Cultural Attachment

American participants reported higher avoidance towards Chinese culture than Chinese participants (M_{Chinese} = 2.272, sd = 0.404; M_{American} = 2.734, sd = 0.679; $t(50) = -3.007$, $p = 0.004$). Conversely, Chinese participants reported higher avoidance towards American culture than American participants (M_{Chinese} = 2.784, sd = 0.500; M_{American} = 2.159, sd = 0.578; $t(50) = 4.178$, $p < 0.001$). Additionally, Chinese participants also reported higher anxiety towards American culture than American participants (M_{Chinese} = 2.476, sd = 0.715; M_{American} = 2.063, sd = 0.532; $t(50) = 2.348$, $p = 0.023$). There was no difference in the anxiety towards Chinese culture.

5.3.2.2 Cultural Identification

Chinese participants identified with the Chinese culture more strongly than the American participants did (M_{Chinese} = 5.326, sd = 0.549; M_{American} = 3.249, sd = 0.998; $t(50) = 9.388$, $p < 0.001$). However, American participants did not identify with American culture more strongly than Chinese participants (M_{Chinese} = 4.960, sd = 0.673; M_{American} = 5.286, sd = 0.772; $t(50) = -1.626$, $p = 0.111$).

5.3.2.3 Other measures

Although participants did not report high levels of stress on average, Chinese participants reported higher levels of stress than American participants (M_{Chinese} = 3.109, sd = 0.115; M_{American} = 3.018, sd = 0.146; $t(50)$ = 2.506, p = 0.014). Although Chinese participants also scored higher in racial essentialism (M_{Chinese} = 3.615, sd = 0.879; M_{American} = 3.181, sd = 0.801; $t(50)$ = 1.856, p = 0.069) and patriotism (M_{Chinese} = 5.290, sd = 0.879; M_{American} = 4.713, sd = 1.247; $t(50)$ = 1.940, p = 0.058) but the differences were not statistically significant.

5.3.2.4 Correlation matrices of Individual Differences

Tables 5.2 to 5.4 contain the correlation matrices of the questionnaire measures of the combined sample, Chinese sample, and American sample respectively. Significant correlations present in both samples are highlighted below and further discussed in the next section.

Strong correlations between each of the various anxiety measures (ECR and both CA) can be observed in both samples as well as the entire group (smallest pairwise r = 0.350; p = 0.073). There is no similar pattern of correlations between the avoidance measures (largest pairwise r = 0.352; p = 0.084). Additionally, the anxiety measures of towards each culture are correlated to their respective avoidance measures (r_{Chinese} = 0.287, p = 0.38; r_{American} = 0.490, p <0.001).

Participants who identified more with Chinese culture reported higher stress levels (r = 0.382, p <0.001) and were more avoidant towards American culture (r = 0.549, p <0.001). Conversely, participants who identified more with American culture reported lower stress levels (r = -0.301, p = 0.029) and were less avoidant towards personal relationships (r = -0.364, p = 0.007).

Patriotism was found to be strongly correlated with the identification towards one's home culture. Patriotic Chinese participants were found to identify with the Chinese culture more (r = 0.449, p = 0.024). On the other hand, American participants who were more patriotic also identified more with the American culture (r = 0.490, p = 0.001) and less with the Chinese culture (r = -0.584, p <0.001). Lastly, participants (from both groups) who believed that race is a fixed category also had a higher need for cognitive closure (r = 0.539, p <0.001).

5.3.3 Behavioral DVs (Reaction Time and Likeability Rating)

Linear mixed effects models were used to examine the effects of the experimental conditions, individual difference measures, and their interactions on three behavioral dependent variables, namely 1) RT_{ARROW}, the time taken for the participant to indicate the direction of the arrow; 2) RT_{LIKE}, the time taken for the participant to rate the random geometric pattern based on likeability; and 3) Likeability, the rating of the geometric pattern.

5.3.3.0.1 Main Interaction Effects Models 1 to 6 (Table 5.5) examined the two interaction effects of the experimental conditions. No significant interaction effects between the experimental conditions were found for all three dependent variables (smallest p = 0.158). Additionally, there is also no significant three-way interaction between the experimental conditions and any individual difference. This suggests that there is lack of support for hypotheses H4 to H6. The following are significant

Table 5.2: Correlation values (r) of Individual Differences - Combined Sample

	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
[1] ECR (Anxiety)	0.011	0.478**	0.009	0.489**	0.167	−0.039	0.016	0.341*	0.297*	0.240	0.320*	−0.034
[2] ECR (Avoidance)		0.187	0.154	0.172	0.153	−0.018	−0.364**	−0.003	0.074	0.113	−0.207	0.045
[3] CHI CA (Anxiety)			0.287*	0.650**	0.190	0.057	0.084	0.203	0.357**	0.094	−0.004	0.068
[4] CHI CA (Avoidance)				−0.076	−0.194	−0.487**	0.182	0.067	0.110	−0.009	−0.129	−0.202
[5] US CA (Anxiety)					0.490**	0.379**	−0.015	0.027	0.239	0.093	0.159	0.136
[6] US CA (Avoidance)						0.549**	−0.388**	−0.344*	−0.040	−0.138	−0.001	0.302*
[7] CHI CI							−0.150	−0.224	0.092	0.024	0.097	0.382**
[8] US CI								0.441**	0.195	0.223	0.065	−0.301*
[9] Need For Closure									0.539**	0.364**	−0.032	−0.143
[10] Racial Essentialism										0.252	−0.062	0.082
[11] Patriotism											−0.003	0.094
[12] Perceived Racism												−0.137
[13] Self-Reported Stress												

Note: ECR = Experiences in Close Relationships (Adult Attachment), CA = Cultural Attachment, CI = Cultural Identification;
Columns numbers correspond to their respective row numbers (i.e. [1] refers to ECR Anxiety and so on).
$^{*}p<0.05$; $^{**}p<0.01$;

Table 5.3: Correlation values (r) of Individual Differences - Chinese Sample

	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
[1] ECR (Anxiety)	0.128	0.637^{**}	0.256	0.593^{**}	0.352	−0.156	0.102	0.328	0.355	0.233	0.208	−0.170
[2] ECR (Avoidance)		0.176	0.345	0.110	0.066	−0.282	−0.256	0.115	−0.005	0.219	−0.276	−0.126
[3] CHI CA (Anxiety)			0.347	0.712^{**}	0.117	0.075	0.336	0.387	0.403^{*}	0.285	0.067	−0.049
[4] CHI CA (Avoidance)				0.094	−0.196	−0.102	−0.015	0.249	0.400^{*}	−0.172	0.127	−0.040
[5] US CA (Anxiety)					0.316	0.199	0.404^{*}	0.352	0.378	0.373	0.105	−0.081
[6] US CA (Avoidance)						−0.010	−0.262	−0.094	−0.114	0.225	−0.075	0.250
[7] CHI CI							0.209	−0.046	0.027	0.449^{*}	0.008	0.161
[8] US CI								0.304	0.356	−0.033	−0.061	−0.208
[9] Need For Closure									0.632^{**}	0.060	−0.246	−0.073
[10] Racial Essentialism										−0.126	0.131	−0.249
[11] Patriotism											−0.094	0.003
[12] Perceived Racism												0.012
[13] Self-Reported Stress												

Note: ECR = Experiences in Close Relationships (Adult Attachment), CA = Cultural Attachment, CI = Cultural Identification;
Columns numbers correspond to their respective row numbers (i.e. [1] refers to ECR Anxiety and so on).
$^{*}p<0.05$; $^{**}p<0.01$;

Table 5.4: Correlation values (r) of Individual Differences - American Sample

	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
[1] ECR (Anxiety)	−0.085	0.350	−0.061	0.392*	−0.002	−0.182	−0.014	0.374	0.225	0.228	0.400*	0.004
[2] ECR (Avoidance)		0.190	0.163	0.186	0.138	−0.147	−0.411*	−0.060	0.089	0.016	−0.182	0.086
[3] CHI CA (Anxiety)			0.328	0.653**	0.259	0.030	−0.084	0.073	0.321	−0.031	−0.069	0.133
[4] CHI CA (Avoidance)				0.030	0.094	−0.391*	0.169	−0.087	0.150	0.209	−0.222	−0.105
[5] US CA (Anxiety)					0.516**	0.270	−0.308	−0.237	−0.105	−0.305	0.175	0.146
[6] US CA (Avoidance)						0.418*	−0.372	−0.499**	−0.283	−0.638**	−0.047	0.109
[7] CHI CI							−0.027	−0.292	−0.322	−0.584**	0.047	0.225
[8] US CI								0.517**	0.193	0.490**	0.206	−0.272
[9] Need For Closure									0.567**	0.622**	0.156	−0.133
[10] Racial Essentialism										0.440*	−0.304	0.194
[11] Patriotism											0.009	0.009
[12] Perceived Racism												−0.317
[13] Self-Reported Stress												

Note: ECR = Experiences in Close Relationships (Adult Attachment), CA = Cultural Attachment, CI = Cultural Identification;
Columns numbers correspond to their respective row numbers (i.e. [1] refers to ECR Anxiety and so on).
$^{*}p<0.05$; $^{**}p<0.01$;

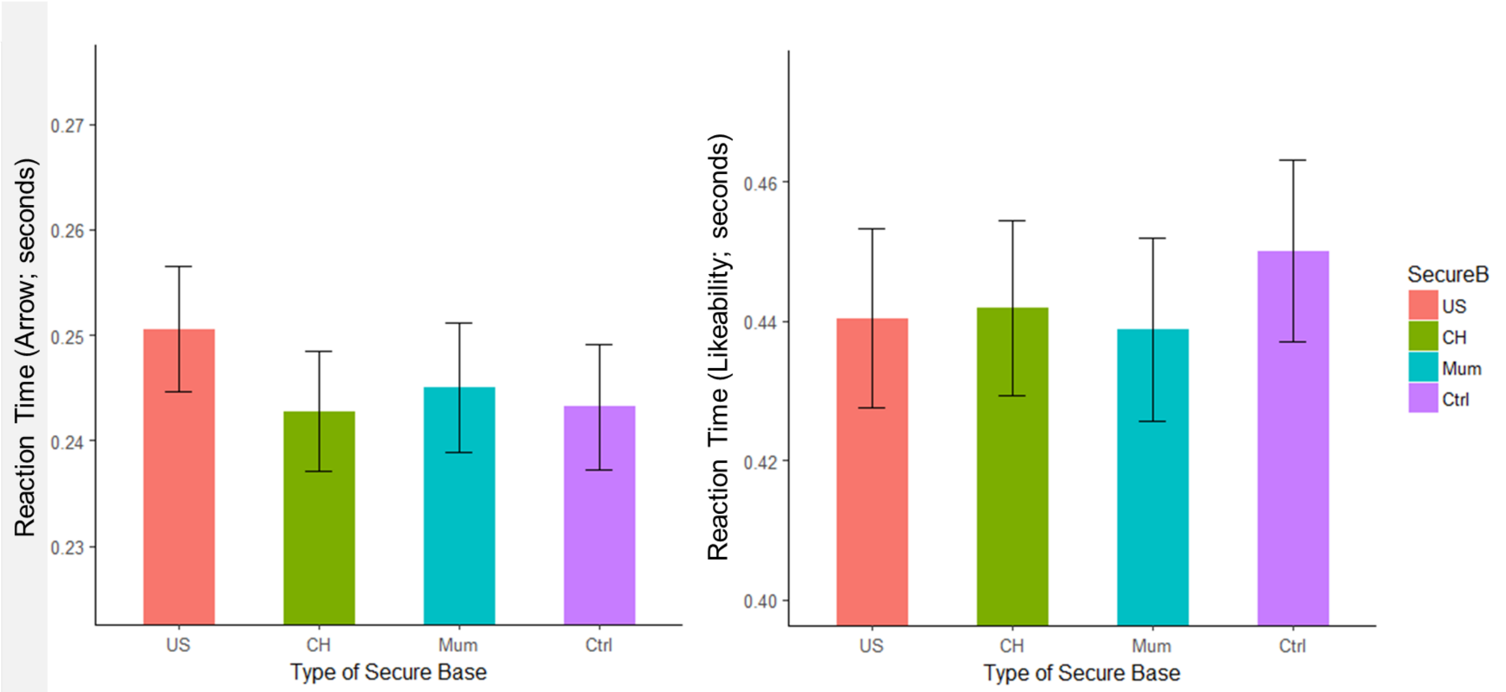

Figure 5.4: Main effects of Secure Base on Reaction Time (Arrow) and Reaction Time (Likeability). Error bars denote +/- 1 standard error.

two way interactions between an experimental condition (threat or secure base) and an individual difference.

There is a significant two-way interaction effect between the presence of threat and the degree of racism participants perceived to have experienced on likeability ratings (Figure 5.5, pg141; $b_{\text{threat*racism}} = 0.376$, $SE = 0.087$, $p < 0.001$). Participants who reported that they experienced more racism differentiate less between threatening and non-threatening trials and score the random geometric patterns in all trials equally. On the contrary, participants who reported experiencing less racism scored random geometric patterns in trials with threat as more negative than trials without threat.

Additionally, there is also a significant two way interaction effect between the types of secure image shown and the participant's avoidance of American culture on likeability ratings (Figure 5.6, pg141; $b_{\text{American\_Control*CAUSavoid}} = -0.074$, SE = 0.037, $p = 0.050$; $b_{\text{American\_Chinese*CAUSavoid}} = -0.123$, $SE = 0.041$, $p = 0.003$). Participants who are more avoidant of American culture tend to score random geometric patterns appearing after a subliminal American secure base as more negative. The opposite trend is found for trials with subliminal Chinese secure base images shown.

5.3.3.1 Other Findings

The following are additional analyses performed to examine if the effect of any one experimental condition or individual difference on the three dependent variables.

5.3.3.1.1 Main Effects: Threat Models 1 to 6 (Table 5.6) examined the main effect of threat on RT_{ARROW}, RT_{LIKE}, and Likeability. Participants were slower in indicating the direction of the arrow ($b_{\text{threat}} = 0.006$, $SE = 0.002$, p=0.01 $t = 2.66$)

Table 5.5: Linear mixed effects models of Behavioral DVs (Two-way interaction of experimental conditions)

	Dependent variable:					
	RT Arrow		RT Likeability		Likeability	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	.245***	.246***	.443***	.442***	1.943***	2.077***
	(.006)	(.003)	(.013)	(.014)	(.025)	(.019)
Threat		.011		−.004		−.299***
		(.007)		(.008)		(.047)
Maternal		−.009		.001		.020
		(.006)		(.007)		(.037)
American		−.002		−.006		.012
		(.007)		(.007)		(.039)
Chinese		−.002		.014*		−.010
		(.007)		(.008)		(.036)
Threat*Maternal		−.0002		.001		−.014
		(.008)		(.011)		(.046)
Threat*American		−.008		.008		.036
		(.008)		(.012)		(.047)
Threat*Chinese		−.012		−.008		.049
		(.009)		(.010)		(.046)
Observations	9,060	9,060	9,060	9,060	9,060	9,060
Log Likelihood	8,085.552	7,997.033	3,630.591	3,615.545	−9,493.964	−9,154.415
Akaike Inf. Crit.	−16,165.100	−15,904.070	−7,255.181	−7,141.089	18,993.930	18,398.830
Bayesian Inf. Crit.	−16,143.770	−15,584.040	−7,233.846	−6,821.066	19,015.260	18,718.850

Note. Standard errors are in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Models (1) to (6) are in the form of: DV $\sim$ IV + (IV|Participant) where IV(1,3,5)=1; IV(2,4,6)=Threat X Secure Base; and DV(1,2)=RT(Arrow); DV(3,4)=RT(Likeability); DV(5,6)=Likeability.

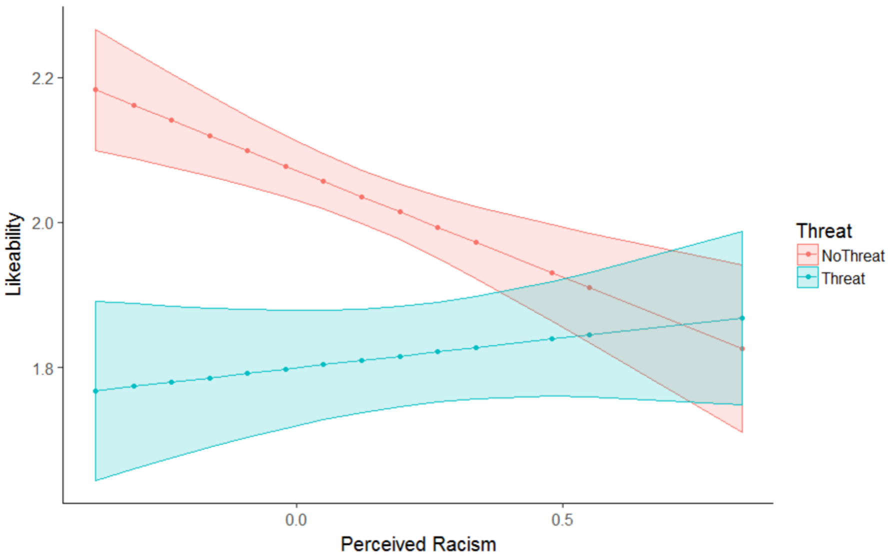

Figure 5.5: Two way interaction of the presence of threat and degree of perceived racism on Likeability ratings. Individuals who perceived higher amounts of racism were more likely to rate non-threatening images poorly. Shaded areas represent +/- 1 standard error.

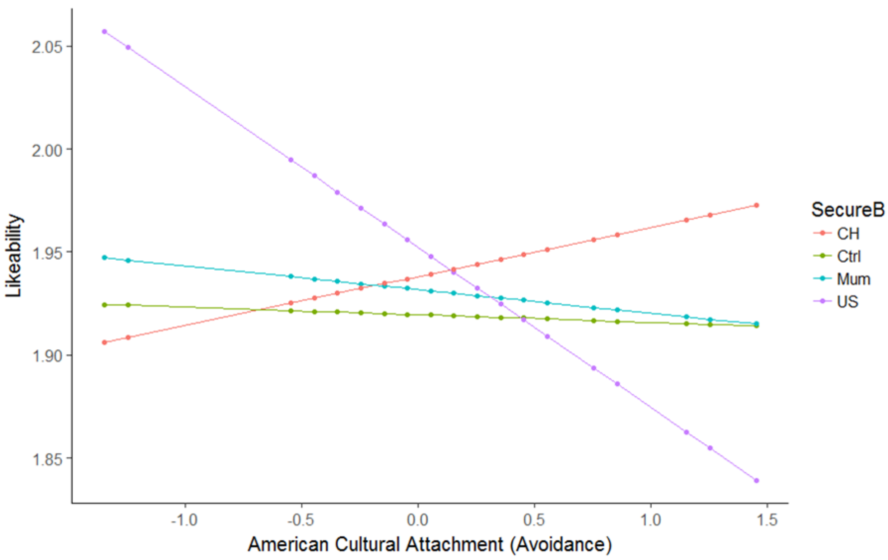

Figure 5.6: Two way interaction of the type of secure base shown and avoidance towards American culture on Likeability ratings. Individuals who are more avoidant of American culture were more likely to give American secure base images more negative ratings. The opposite trend is found for Chinese secure base images. Shaded areas represent +/- 1 standard error.

and also gave more negative ratings (b_{threat} = -0.282, *SE* = 0.046, $p<0.001$ t = -6.08) in the presence of threatening images rather than non-threatening images. However, there was no significant difference in RT_{LIKE} (b_{threat} = -0.004, *SE* = 0.004, p=0.29 t = -1.06).

5.3.3.1.2 Main Effects: Secure Base Models 1 to 3 (Table 5.7; Figure 5.4, pg138) examined the main effect of the type of secure base on RT_{ARROW}, RT_{LIKE}, and Likeability. The notation $b_{\text{A\_B}}$ indicates the estimate for the pairwise comparison between condition A and B with condition B as the reference condition.

Participants were significantly faster in indicating the direction of the arrow when Chinese ($b_{\text{Chinese\_Control}}$ = -0.007, *SE* = 0.003, p=0.011) and maternal ($b_{\text{Maternal\_Control}}$ = -0.007, *SE* = 0.003, p=0.010) images were presented and marginally faster when American images ($b_{\text{American\_Control}}$ = -0.005, *SE* = 0.003, p=0.080) were presented as compared to when control images were presented. There was no significant difference between the cultural and maternal conditions (smallest pairwise p = 0.447).

Participants were significantly slower in rating the random geometric pattern when Chinese images were presented as compared to when control ($b_{\text{Chinese\_Control}}$ = 0.009, SE = 0.004, p=0.046) and American ($b_{\text{Chinese\_American}}$ = 0.011, *SE* = 0.004, p=0.021) images were presented and marginally slower as compared to when maternal images ($b_{\text{Chinese\_Maternal}}$ = 0.008, *SE* = 0.004, p=0.096) were presented. No other significant differences were found (smallest pairwise p = 0.515).

No significant differences were found in likeability ratings (smallest pairwise p = 0.131).

Table 5.6: Linear mixed effects models of Behavioral DVs (Threat)

	Dependent variable:					
	RT Arrow		RT Likeability		Likeability	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.245***	0.242***	0.443***	0.445***	1.943***	2.084***
	(0.006)	(0.005)	(0.013)	(0.013)	(0.025)	(0.027)
Threat		0.006***		−0.004		−0.282***
		(0.002)		(0.004)		(0.046)
Observations	9,060	9,060	9,060	9,060	9,060	9,060
Log Likelihood	8,085.552	8,087.418	3,630.591	3,626.645	−9,493.964	−9,103.391
Akaike Inf. Crit.	−16,165.100	−16,162.830	−7,255.181	−7,241.290	18,993.930	18,218.780
Bayesian Inf. Crit.	−16,143.770	−16,120.170	−7,233.846	−7,198.620	19,015.260	18,261.450

Note. Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
Models (1) to (6) are in the form of: DV $\sim$ IV + (IV|Participant) where IV(1,3,5)=1; IV(2,4,6)=Threat; and DV(1,2)=RT(Arrow); DV(3,4)=RT(Likeability); DV(5,6)=Likeability.

Table 5.7: Linear mixed effects models of Behavioral DVs (Secure Base)

	Dependent variable:		
	RT Arrow	RT Likeability	Likeability
	(1)	(2)	(3)
Intercept	.251***	.440***	1.928***
	(.006)	(.013)	(.030)
Maternal	−.008**	.001	.011
	(.003)	(.005)	(.021)
American	−.006*	−.002	.031
	(.003)	(.005)	(.021)
Chinese	−.007**	.010**	.015
	(.003)	(.005)	(.021)
Observations	9,060	9,060	9,060
Log Likelihood	8,076.026	3,620.798	−9,500.455
Akaike Inf. Crit.	−16,122.050	−7,211.596	19,030.910
Bayesian Inf. Crit.	−16,015.380	−7,104.922	19,137.580

Note. Standard errors are in parentheses. *$p<0.1$; **$p<0.05$; ***$p<0.01$
Models (1) to (3) are in the form of: DV $\sim$ IV + (IV|Participant) where IV(1,2,3)=Secure Base; and DV(1)=RT(Arrow); DV(2)=RT(Likeability); DV(3)=Likeability.

Table 5.8: Linear mixed effects models of Behavioral DVs (Ind Differences)

	Dependent variable:		
	RT Likeability		
	(1)	(2)	(3)
Intercept	$.443^{***}$	$.442^{***}$	$.443^{***}$
	(.013)	(.012)	(.012)
CA Avoidance (American)		$.054^{***}$	
		(.019)	
CA Avoidance (Chinese)			$-.055^{***}$
			(.017)
Observations	9,060	9,060	9,060
Log Likelihood	3,630.591	3,631.322	3,631.914
Akaike Inf. Crit.	−7,255.181	−7,250.644	−7,251.828
Bayesian Inf. Crit.	−7,233.846	−7,207.974	−7,209.158

Note. Standard errors are in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
Models (1) to (3) are in the form of: DV $\sim$ IV + (IV|Participant) where IV(1)=1; IV(2)=Cultural Attachment (Avoidance) towards US; IV(3)=Cultural Attachment (Avoidance) towards CH; and DV(1)=RT(Arrow); DV(2)=RT(Likeability); DV(3)=Likeability.

5.3.3.1.3 Main Effects: Individual Differences Models 1 to 3 (Table 5.8) examined the main effects of the various individual differences on RT_{ARROW}, RT_{LIKE}, and Likeability. Only two significant effects were found. Participants who were more avoidant of American culture were significantly slower in rating the random geometric pattern ($b_{\text{CA-US-Avoidance}}$ = 0.054, *SE* = 0.019, *p* = 0.006). On the other hand, participants who were more avoidant of Chinese culture were significantly faster ($b_{\text{CA-CH-Avoidance}}$ = -0.055, *SE* = 0.017, *p* = 0.002).

5.3.4 Results: fMRI

The fMRI results are presented in the section below and organized based on the different contrasts used to obtain them. The results for each contrast contain differences in BOLD responses following each onset (arrow and likeability questions) and the various samples (combined, Chinese, and American). Unless otherwise mentioned, BOLD responses refer to the parameters for beta weights. For clearer presentation, the onset of the arrow question will be known as onset A and the onset of the likeability question will be known as onset B. Unless otherwise mentioned, results discussed are obtained from a whole brain analysis of the selected sample thresholded at $p < 0.001$ (uncorrected) and $k > 10$ (k being the number of voxels in the same cluster). This threshold is selected as suggested elsewhere (Liberman 2009). In order to correct for multiple comparisons, the family-wise-error (FWE) corrected p value is calculated and thresholded at $p_{FWE} < 0.05$. Lastly, the MNI coordinates in parentheses represent the location of the voxel with the peak activation.

5.3.4.1 Interaction Effects: Threat x Secure Base

To test H1 to H3, a specific contrast was used to locate BOLD responses which were higher when the participant was threatened but only when American or Control secure bases were shown in conjunction. Results are summarized in Table 5.9. BOLD responses of the left dlPFC (MNI: x = -18, y = 56, z = 29; p_{FWE} = 0.039) and right mPFC (MNI: x = 3, y = 56, z = 23; p_{FWE} = 0.381) in Chinese participants were found to follow the hypothesized pattern (see Figure 5.7, pg149). ROI analyses (10mm spheres at x = -18, y = 56, z = 29, and x = 3, y = 56, z = 23) revealed similar findings (with Chinese and American images interchanged) only at the dlPFC (MNI: x = -15, y = 53, z = 35; p_{FWE} = 0.001) for the American participants (see Figure 5.8, pg150). From the results, H1 and H3 are supported while H2 is not.

5.3.4.2 Other Results: Main Effects of Threat vs. Non Threat

Other than testing the hypotheses directly, differences in BOLD activations due to the main effect of experimental conditions are also examined. In trials where threatening images were presented instead of non-threatening images, BOLD response following onset A was higher in the right mPFC (MNI: x = 3, y = 53, z = 23; p_{FWE} = 0.206). ROI analysis over the same conditions revealed higher BOLD responses in the amygdala (*M* = 0.161, *SE* = 0.063, *p* = 0.014), insula (*M* = 0.088, *SE* = 0.024, *p* = 0.001), and pallidum (*M* = 0.097, *SE* = 0.032, *p* = 0.004).

When only examining BOLD responses of Chinese participants, a similar right mPFC (MNI: x = 6, y = 53, z = 26; p_{FWE} = 0.065) activation was found. ROI analysis over the same conditions revealed higher BOLD responses in the insula (*M* = 0.114, *SE* = 0.028, *p* = 0.001), hippocampus (*M* = 0.546, *SE* = 0.206, *p* = 0.014), angular gyri (*M* = 0.185, *SE* = 0.071, *p* = 0.016), and pallidum (*M* = 0.1499,

Table 5.9: Coordinates Table I

Contrast	Sample	Analysis	Region	Onset	x	y	z	p_{FWE}	k	p_{cluster}	p_{area}
Threat x Secure Base	CH	Whole	L DLPFC	A	-18	56	29	.039	29	.020	
	CH	Whole	R MPFC	A	3	56	23	.381	46	.005	
	US	ROI(sphere)	L DLPFC	A	-15	53	35	.001	16	.005	
Threat>N Threat	Comb	Whole	R MPFC	A	3	53	23	.206	32	.015	
	Comb	ROI(area)	LR amygdala	A							.014
	Comb	ROI(area)	LR insula	A							.001
	Comb	ROI(area)	LR pallidum	A							.004
	CH	Whole	R MPFC	A	6	53	26	.065	45	.005	
	CH	ROI(area)	LR insula	A							.001
	CH	ROI(area)	LR pallidum	A							.014
	CH	ROI(area)	LR hippocampus	A							.016
	CH	ROI(area)	LR angular gyrus	A							.001
	US	ROI(area)	LR thalamus	B							.014
Threat<N Threat	US	Whole	L postcentral	A	-48	-31	17	.540	13	.101	
	US	Whole	L premotor	A	-60	8	14	.543	18	.058	
	US	Whole	L SMA	A	-6	8	53	.905	27	.024	
	US	Whole	L IPS	A	24	8	56	.928	14	.090	
	CH	ROI(area)	LR insula	B							.019
	CH	ROI(area)	LR angular gyrus	B							.005
Chinese>Others	CH	Whole	R IPS	A	33	-52	41	.067	58	.002	
	CH	Whole	R premotor	A	39	-1	47	.181	26	.026	
	CH	Whole	R DLPFC	A	-27	-88	2	.402	18	.058	
	CH	Whole	L Middle Occipital	A	-33	53	-1	.595	15	.080	
	CH	Whole	L IPS	A	-33	-58	53	.008	39	.067	
Chinese<Others	CH	Whole	R MPFC	A	9	62	20	.034	17	.064	
	US	Whole	R MPFC	A	21	50	8	.005	21	.042	
US<Others	CH	Whole	L Middle Occipital	A	-27	88	2	.709	16	.072	

p_{FWE} refers to p-value of peak voxel in whole brain analysis; k refers to the number of voxels in the cluster; p_{cluster} refers to the uncorrected p-value for the cluster containing the peak voxel; p_{area} refers to the p-value of selected region in the ROI analysis

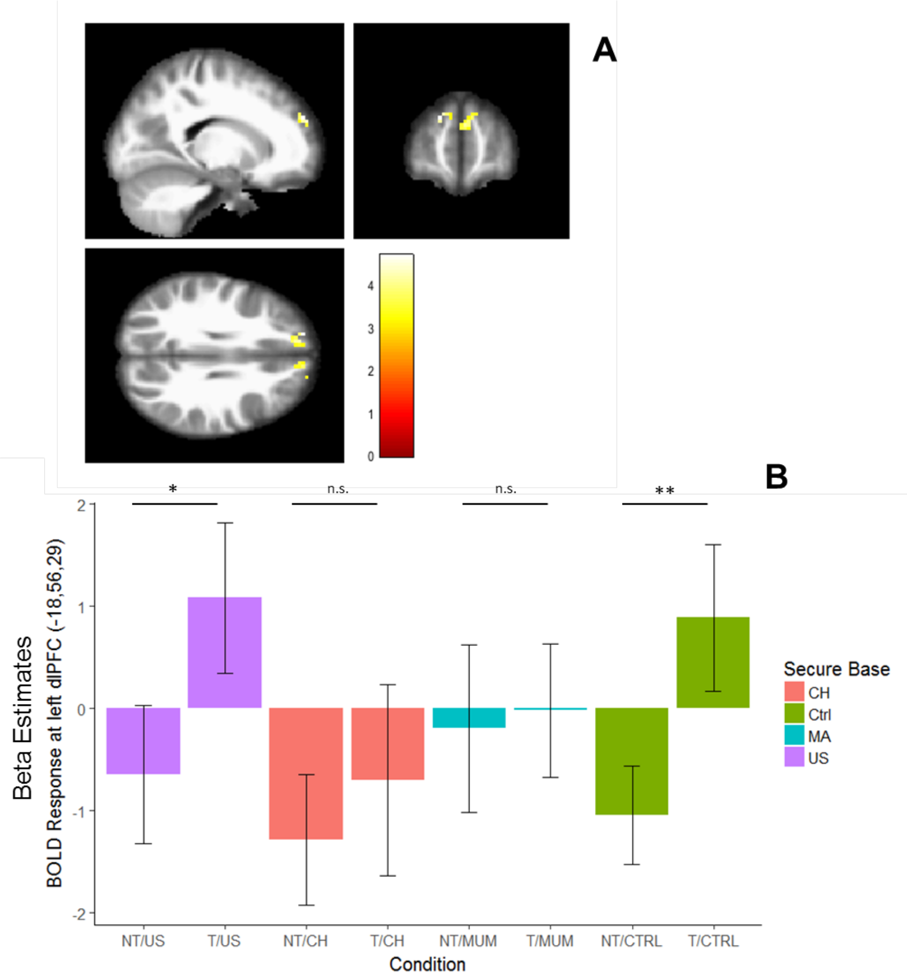

Figure 5.7: BOLD response of Chinese participants for the interaction effect between the presence of threat and type of subliminal image shown. Results are shown at a peak voxel of threshold $p_{\text{FWE}} < 0.05$, family wise corrected for whole brain analysis, and cluster size, $k > 5.4$. Image shown is thresholded at $p < 0.001$ (uncorrected). A) Activation map shown against an average brain. B) Average activations in each condition. Experimental conditions are as follows: NT = Non-threatening (supraliminal); T = Threatening (supraliminal); MA = Maternal Attachment (subliminal maternal image); CH = Chinese (subliminal home culture symbol); US = American (subliminal host culture symbol); CTRL = Control (subliminal control image). ** $p < 0.05$, * $p < 0.10$; Error bars denote +/- 1 standard error.

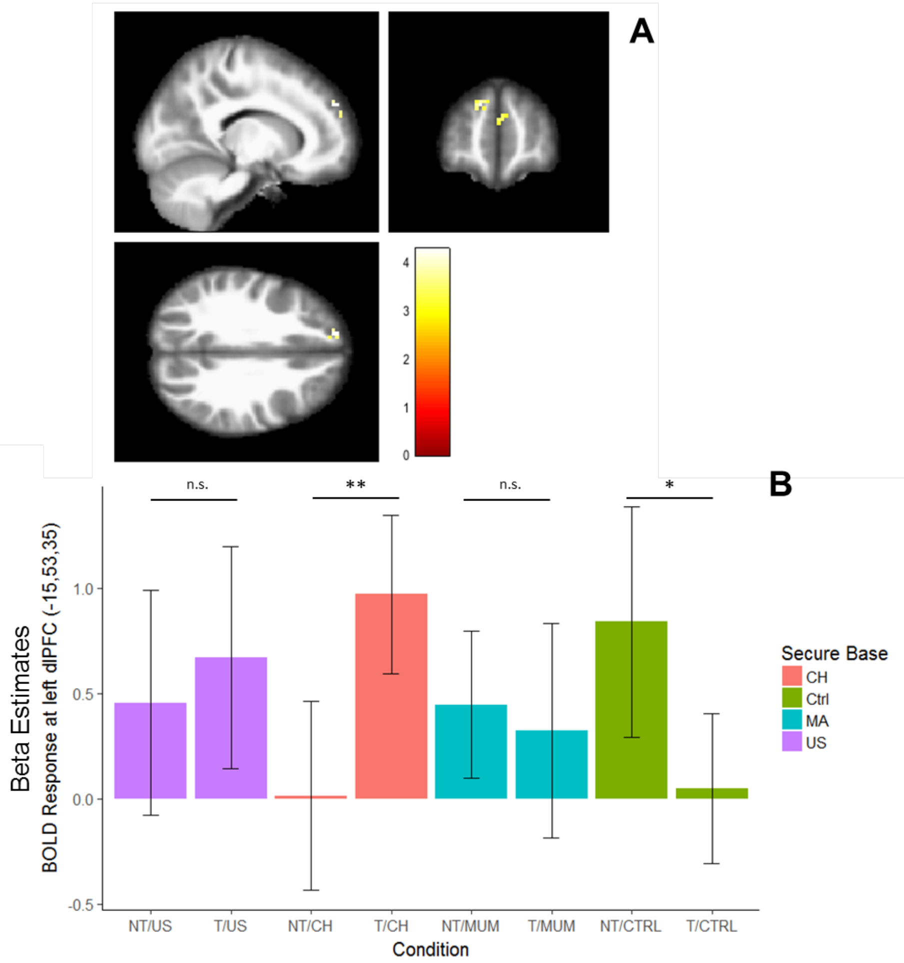

Figure 5.8: BOLD response of American participants for the interaction effect between the presence of threat and type of subliminal image shown. Results are shown at a peak voxel of threshold $p_{\text{FWE}} < 0.05$, family wise corrected for whole brain analysis, and cluster size, $k > 5.4$. Image shown is thresholded at $p < 0.001$ (uncorrected). A) Activation map shown against an average brain. B) Average activations in each condition. Experimental conditions are as follows: NT = Non-threatening (supraliminal); T = Threatening (supraliminal); MA = Maternal Attachment (subliminal maternal image); CH = Chinese (subliminal home culture symbol); US = American (subliminal host culture symbol); CTRL = Control (subliminal control image). ** $p < 0.05$, * $p < 0.10$; Error bars denote +/- 1 standard error.

SE = 0.0417, *p* = 0.001).

Additionally, ROI analysis of American participants also revealed BOLD responses following onset B to be higher in the thalamus (*M* = 0.515, *SE* = 0.196, *p* = 0.014).

In trials where non-threatening images are presented instead of threatening images, BOLD responses of American participants following onset A were higher in the left postcentral gyrus (MNI: x = -48, y = -31, z = 17; p_{FWE} = 0.540), left premotor cortex (MNI: x = -60, y = 8, z = 14; p_{FWE} = 0.543), left SMA (MNI: x = -6, y = 8, z = 53; p_{FWE} = 0.905), and right IPS (MNI: x = 24, y = 8, z = 56; p_{FWE} = 0.928).

ROI analysis of Chinese participants revealed BOLD responses following onset B to be higher in the insula (*M* = 0.089, *SE* = 0.035, *p* = 0.019) and angular gyri (*M* = 0.280, *SE* = 0.089, *p* = 0.005).

5.3.4.3 Other Results: Main Effects of Chinese images vs other secure base images

In trials where Chinese secure bases were shown instead of all other secure base (American, Maternal, Control) imageswhen only examining Chinese participants, BOLD responses were higher in the premotor cortex (MNI: x = 39, y = -1, z = 47; p_{FWE} = 0.181), left IPS (MNI: x = -33, y = -58, z = 53; p_{FWE} = 0.067), right IPS (MNI: x = 33, y = -52, z = 41; p_{FWE} = 0.433), left dlPFC (MNI: x = -27, y = -88, z = 2; p_{FWE} = 0.402), and left middle occipital lobe (MNI: x = -33, y = 53, z = -1; p_{FWE} = 0.595). In the same trials, BOLD responses following onset B were higher in the ACC (MNI: x = -3, y = 41, z = -1; p_{FWE} = 0.506) and mPFC (MNI: x = 6, y = 62, z = 5; p_{FWE} = 0.717).

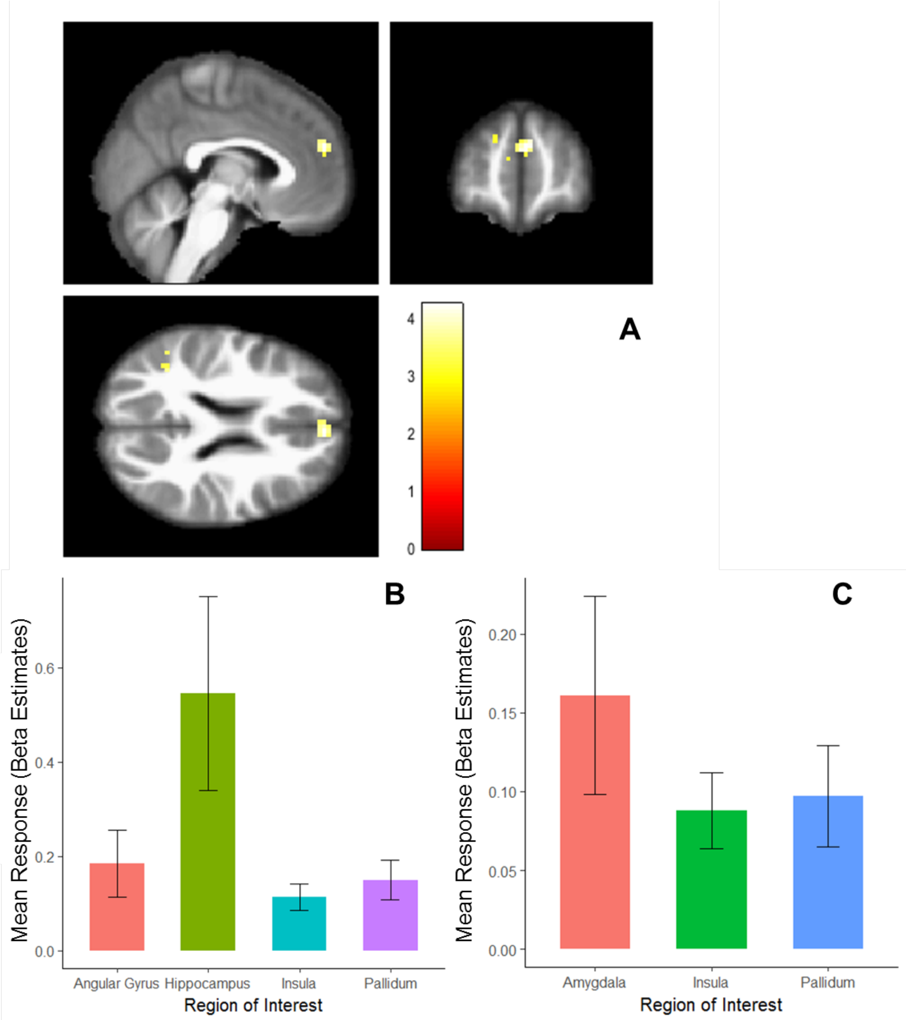

Figure 5.9: A) BOLD response of all participants for the main effect of threat. Results are shown at a peak voxel of threshold p_{FWE} <0.05, family wise corrected for whole brain analysis, and cluster size, k >5.4. Image shown is thresholded at p<0.001 (uncorrected). B) Significant regions from ROI analysis for the main effect of threat in Chinese participants. C) Significant regions from ROI analysis for the main effect of threat in all participants. Error bars denote +/- 1 standard error.

Conversely, in trials when the other secure base images were shown instead of Chinese secure base images, when only examining Chinese participants, BOLD responses were similarly higher in the mPFC (MNI: x = 9, y = 62, z = 20; p_{FWE} = 0.034). When only examining American participants, BOLD responses were higher in the right mPFC (MNI: x = 21, y = 50, z = 8; p_{FWE} = 0.005).

5.3.4.4 Other Results: Main Effects of American images vs other secure base images

In trials where American secure bases were shown instead of all other secure base images, when only examining Chinese participants, BOLD responses were similarly higher in the middle occipital gyrus (MNI: x = -27, y = -88, z = 2; p_{FWE} = 0.709).

5.3.4.5 Other Results: Main Effects of Chinese images vs control images

In trials where Chinese secure bases were shown instead of control images, ROI analysis of American participants revealed higher activations in the pallidum (M = 0.089, SE = 0.037, p = 0.023).

5.3.4.6 Other Results: Main Effects of Chinese vs American images

In trials where American secure bases were shown instead of Chinese images, ROI analysis of American participants revealed higher activations in the insula (M = 0.067, SE = 0.030, p = 0.034) and pallidum (M = 0.079, SE = 0.026, p = 0.005).

5.3.4.7 Interaction Effects: ROI Analyses

ROI analysis was also used to examine brain activations in specific pairs of conditions. The following ROI analysis were used to compare differences in activations when threatening images were shown instead of non-threatening images while a specific type of secure base was shown. The following results are displayed in Table 5.10.

Control images (Threat > Non-Threat) : In trials where control images were shown as secure bases, ROI analysis revealed that BOLD activations following onset A are higher in the amygdala (*M* = 0.063, *SE* = 0.032, *p* = 0.050). When only examining Chinese participants, BOLD activations in the insula (*M* = 0.047, *SE* = 0.020, *p* = 0.031) and pallidum (*M* = 0.062, *SE* = 0.028, *p* = 0.039) are found to be higher. Conversely, ROI analysis of American participants found higher activations in the thalamus (*M* = 0.228, *SE* = 0.087, *p* = 0.015) when non-threatening images were shown instead of threatening images.

Chinese images (Threat > Non-Threat) : In trials where Chinese images were shown as secure bases, ROI analysis revealed that BOLD activations following onset A are higher in the insula (*M* = 0.056, *SE* = 0.016, *p* = 0.001), angular gyri (*M* = 0.054, *SE* = 0.025, *p* = 0.038), and pallidum (*M* = 0.038, *SE* = 0.018, *p* = 0.033). When only examining Chinese participants, BOLD activations in the insula (*M* = 0.069, *SE* = 0.024, *p* = 0.008) and pallidum (*M* = 0.051, *SE* = 0.019, *p* = 0.010) were found to be higher. When only examining American participants, BOLD activations in the insula (*M* = 0.043, *SE* = 0.021, *p* = 0.046) and angular gyrus (*M* = 0.083, *SE* = 0.031, *p* = 0.013) were found to be higher.

Chinese images (Non-Threat > Threat) : When non-threatening images were shown instead of threatening images, in the trials where Chinese images were shown as secure bases, ROI analysis revealed that BOLD activations following onset B are higher in the insula (*M* = 0.048, *SE* = 0.017, *p* = 0.006). When only examining American participants, BOLD activations in the insula (*M* = 0.038, *SE* = 0.019, *p* = 0.049) and angular gyrus (*M* = 0.141, *SE* = 0.047, *p* = 0.006) were found to be higher.

American images (Threat > Non-Threat) : In trials where America images were shown as secure bases, ROI analysis revealed that BOLD activations following onset A are higher in pallidum (*M* = 0.032, *SE* = 0.014, *p* = 0.032). When only examining Chinese participants, BOLD activations in the thalamus (*M* = 0.203, *SE* = 0.094, *p* = 0.040) and pallidum (*M* = 0.054, *SE* = 0.023, *p* = 0.026) were found to be higher. Conversely, when non-threatening images were shown instead of threatening images, in the trials where American images were shown as secure bases, ROI analysis revealed that BOLD activations following onset B are higher in the thalamus (*M* = 0.244, *SE* = 0.021, *p* = 0.006).

Maternal images (Threat > Non-Threat) : In trials where maternal images were shown as secure bases, ROI analysis of Chinese participants revealed that BOLD activations following onset B are higher in insula (*M* = 0.047, *SE* = 0.022, *p* = 0.043).

5.3.4.8 Habituation Effects

One concern for the results in this study is that with the longer study duration and multiple repetitions showing the same images, participants would habituate to the images and no longer show differences between them. The time taken for all

Table 5.10: Coordinates Table II

Contrast	Sample	Analysis	Region	Onset	p_{area}
Chinese>Control	US	ROI(area)	LR pallidum	B	.023
American>Chinese	US	ROI(area)	LR insula	B	.034
	US	ROI(area)	LR insula	B	.005
Chinese Images					
Threat>N Threat	Comb	ROI(area)	LR insula	A	.001
	Comb	ROI(area)	LR angular gyrus	A	.038
	Comb	ROI(area)	LR pallidum	A	.033
	CH	ROI(area)	LR insula	A	.008
	CH	ROI(area)	LR pallidum	A	.010
	US	ROI(area)	LR insula	A	.046
	US	ROI(area)	LR angular gyrus	A	.013
Threat<N Threat	Comb	ROI(area)	LR insula	B	.006
	US	ROI(area)	LR insula	B	.049
	US	ROI(area)	LR angular gyrus	B	.006
American Images					
Threat>N Threat	Comb	ROI(area)	LR pallidum	A	.032
	CH	ROI(area)	LR pallidum	A	.026
	CH	ROI(area)	LR thalamus	A	.040
Threat<N Threat	CH	ROI(area)	LR thalamus	B	.006
Control Images					
Threat>N Threat	Comb	ROI(area)	LR amygdala	A	.050
	CH	ROI(area)	LR insula	A	.031
	CH	ROI(area)	LR pallidum	A	.039
Threat<N Threat	US	ROI(area)	LR thalamus	A	.015
Maternal Images					
Threat>N Threat	CH	ROI(area)	LR insula	B	.043

the trials to complete is approximately 10 to 12 minutes. As the task involves the repetition of the same images several times, there could be potential habituation effects. As the participants get used to the stimuli and also more fatigued, any differences in the BOLD activity between different conditions could be eliminated. To control for these potential habituation effects, a separate analysis was conducted only on trials in the front half of the scanning session. However, the analysis did not reveal any significant differences in all of the contrasts that were tested above. This could be due to the reduced power when only using half of the total trials. Figure 5.10 below shows the graph of each condition based on the same peak voxel identified in the main result (5.3.4.1).

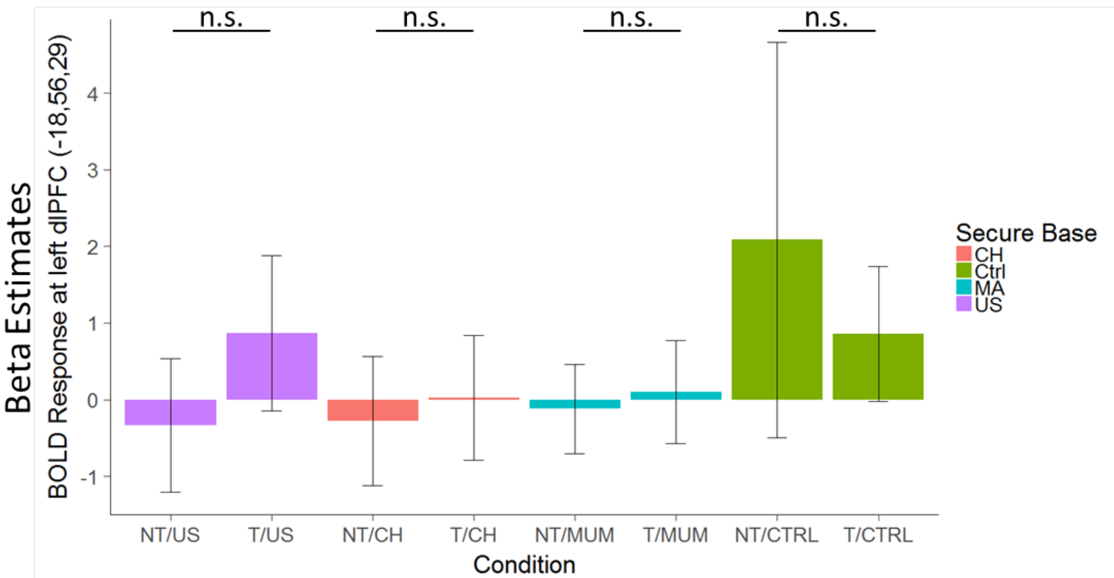

Figure 5.10: BOLD response of Chinese participants in the first half of the experiments for the interaction effect between the presence of threat and type of subliminal image shown. Experimental conditions are as follows: NT = Non-threatening (supraliminal); T = Threatening (supraliminal); MA = Maternal Attachment (subliminal maternal image); CH = Chinese (subliminal home culture symbol); US = American (subliminal host culture symbol); CTRL = Control (subliminal control image). ** $p < 0.05$, * $p < 0.10$; Error bars denote +/- 1 standard error.

5.4 Discussion

The hypotheses tested in the study were partially supported. There is sufficient support for H1 and H3 but there does not seem to be support for the other hypotheses. The rest of the hypotheses are discussed below but in general, there is lack of support for H4 to H7. In support of H1, the left dlPFC and dorsal mPFC were found to be sensitive to home cultural symbols in the face of threat. The left dlPFC finding supports H3 that emotion regulation processes are involved in the presence of home cultural symbols and threat. Specifically, in Chinese participants, host cultural and control images led to an increase in left dlPFC response during threat whereas home cultural and maternal images did not. In American participants, maternal images also led to an increase in left dlPFC responses. The results also indicate that the dorsal portion of the mPFC is sensitive to the same symbols but only in the Chinese participants. Following from Kohn's (2014) model, there are other brain regions (e.g. angular gyrus, SMA, STG) that could be predicted to show differences in BOLD activation under the same conditions. Similarly, following from the conceptual model (Figure 2.2), there are other regions (e.g. amgydala - as per H2, motor regions, hypothalamus, reward processing regions, hippocampus etc.) that could be predicted to show such differences. However, there were no significant differences found in those regions.

On one hand, the prefrontal findings match up well with prior literature which suggested that the dlPFC and dmPFC are recruited in uninstructed (automated) emotion regulation (Kohn et al., 2014; Silvers et al., 2013; Staudinger et al., 2011; Ochsner and Gross, 2005). Additionally, the left prefrontal cortex is related to approach behaviours in threat processing as well (Jonas et al., 2014). On the other hand, the lack of findings in the other areas proposed in chapter 2.4.4 (e.g. amygdala, insula) suggests that the dlPFC might not have been able to successfully regulate the negative emotions. As a result, although this study provides early evidence that cultural symbols aid in emotion regulation, more research is needed to assess the effectiveness of the symbols. This is discussed in the next chapter together with the direction of future research on this topic.

Other than the regions identified above, regions which were sensitive to only threatening stimuli or cultural stimuli also provide an insight on the process of how cultural attachment works in the brain. The findings in the study indicate that the primary affective processing regions (i.e. amygdala, insula) were activated when participants were under threat. This follows from a long line of research suggesting that the threatening images were indeed inciting a fear-like response. Additionally, regions associated with motivational salience (ventral pallidum; Napier and Mickiewicz, 2010) was also activated under threat suggesting that participants were motivated to respond to the stimulus. The results showing the main effect of threat also demonstrate the role of the (d)mPFC in threat processing. This follows from previous literature suggesting that the threats presented were processed in a more deliberate fashion and not just at the affective level (i.e. the thalamo-amygdala network). For example, researchers found that when exposed to low threat situations, unlike the direct activation of the amygdala in high threat situations, the amygdala of rats was activated through the mPFC instead (Moscarello and Maren, 2018). The above discussion sums up the neural activations in both samples. However, the findings between the Chinese and American samples were not always consistent. In particular, more neural activations are found in the American participants, especially in the contrast between non-threatening images and threatening ones. Various areas relating to emotion regulation, somatosensory, and motor responses were activated when the non-threatening images were shown. These results suggest that there is constant emotion regulation taking place in American participants and the possibility that the familiar environment (i.e. they are not abroad) cause threats to be processed differently. A similar finding is that individuals who perceived higher amounts of racist behavior towards them were more likely to give lower likeability ratings in trials without threat. There appears to be a numbing effect from the constant threats felt. Due to the limitations of the scope of recruitment in this study, future studies conducted with Americans who are abroad are needed.

H4a, H4b, and H4c predicted that the presence of home cultural symbols would mitigate the behavioral responses (likeability ratings, reaction time in indicating the arrow, and reaction time in indicating the likeability rating respectively) to threat. However, there was no support for each of the hypotheses. Each hypothesis in H5 to H7 was contingent on their respective hypothesis in H4. However, since the predicted difference in H4a, H4b and H4c were not found, the moderations were not justified. Likeability ratings from the affective transfer task were only influenced by the presence of threat but not cultural symbols. Unlike the initial hypothesis, likeability ratings were not able to capture the security provided by the cultural symbols. These results follow a similar pattern to activations in the affect generation regions of the brain. Additionally, the anxiety and avoidance levels of individuals towards their home culture did not significantly moderate this effect. Consolidating the results from the behavioral responses and affective regions in the brain, even though the emotion regulation regions of the brain are recruited, the cultural symbols did not seem to successfully mitigate the negative emotions generated from threats. Previous studies have found that likeability ratings were sensitive to cultural symbols (Hong et al., 2013) and relationship primes (Mikulincer et al., 2001b)). Those studies were not performed with the participant being in an fMRI scanner and used a more sensitive scale (5-point or 7-point Likert scales). That being said, there are other possible explanations for the lack of these findings. For one, these measures assume that the mitigation in threat occurs in the affective regions and have a rapid effect on self-reported affect. However, it is entirely possible that the mitigation occurs over a longer period of time and differences can only be observed later down the line (e.g. in SCR). Further studies combining these different modalities are needed before conclusive statements can be made but the shortcomings of the current design should definitely be taken in account in future experiments.

Other than threat, the individual's avoidance towards a culture seemed to generate negative affect as well. Regardless of whether threat is present, individuals who were more avoidant of a culture rated the random pattern more negatively in trials where the corresponding cultural symbol was shown. Additionally, the likeability ratings in trials with the other culture would be higher. This reinforces the notion that attachment avoidance refers to individuals with a negative sense of others - in this case, the culture (Gander and Buchheim, 2015). This finding suggests that the cultural symbols are in and of themselves threats to the participants. In the brain, participants who were more avoidant of Chinese culture recruited the superior temporal sulcus, a region previously related to social perception (Grossman and Blake, 2001) and theory of mind (Beauchamp, 2015), more in control trials than in Chinese trials.

Participants reacted slower in indicating the direction of the arrow in threatening trials over non-threatening trials. This is in line with prior studies suggesting that the anxiety and fear generated from threatening situations slow down the responses of individuals (Cloitre et al., 1992). However, the anxiety subscales of the attachment scales did not significantly predict differences in reaction time. A possible interpretation is that the slowdown could be due to the threatening stimuli being more distracting instead of actually inciting anxiety and fear (Mogg et al., 2008). Although similar results were found in control trials when compared to all other three types of secure bases, this could be due to the ambiguity of the control stimuli resulting in longer cognitive processing in comparison to the other stimuli which were usually less novel and easily categorized.

Some findings between the relationships of individual differences stand out. In particular, the correlations between the anxiety subscales of each of the attachment scales support the assertion that the anxiety reflects a negative sense of the self (Gander and Buchheim, 2015). Despite the domains of the anxiety being different, this finding suggests that there is an underlying theme across these domains. This is useful in addressing the possible impact of early childhood experiences with relationships and social bonding on eventual perceptions of adult relationships and culture. Additionally, there are possible differences in the interpretation of patriotism in both samples. In both samples, being patriotic is correlated to identifying with the home country as well as having a higher need for closure. Americans who are more patriotic also identified less with Chinese culture, were less avoidant of American culture, and were more likely to believe that there is an essence to race. These correlations were not present in the Chinese sample. As there are limited correlations between these variables and cultural attachment, this could be due to the changes in worldview from the experiences of being in a foreign country rather than intrinsic differences rooted in the upbringing of the individual.

A possible limitation of the study is the complicated task design. Although one of the initial research questions was to examine the similarities between home cultural, host cultural, and maternal symbols, it quickly became obvious that comparisons of such natures are difficult to make in the brain where multiple corrections are in place. Future studies should take note of the possible conflicting stimuli (e.g. host cultural stimuli leading to negative affect). That being said, the findings made despite the noise can be said to be reinforced and more likely to be strong results. Other limitations of the method were discussed in chapter 3.

All in all, this study provides a first but significant look at the neural pathways involved in cultural attachment. Cultural symbols were shown to initiate emotion regulation even though the success of that emotion regulation cannot be measured exactly yet. The likeability ratings were able to capture lingering affective responses of the individuals and the reaction time measures were able to suggest if cognitive processes were taking place. As such, in future studies, these measures should continue to be used in examining the multi-step process of attachment. In the next chapter, a summary of both studies and the multimodal evidence collected so far will consolidate the findings in these studies as well as provide future directions in which research of cultural attachment can go.

Chapter 6

General Discussion and Conclusion

Cultural attachment is a nascent research area which suggests that cultural groups and cultural symbols are capable of mitigating threat responses felt by individuals, based on similar principles to parental and adult attachment theory. Even though early experiments have shown promise by revealing the successful mitigation of behavioral threat responses using cultural symbols, there remained a lack of evidence of biological responses or potential mechanisms behind the process. This thesis aimed to bridge this research gap by answering the following three research questions:

1. Does the presence of cultural stimuli from an individual's primary culture reduce the biological responses to threat?
2. Are brain regions responsible for a) threat detection, b) threat evaluation, c) emotion regulation, d) reward processing, e) memory recall, f) HPA axis activity, and g) other possible components of attachment, activated in the presence of threat and cultural stimuli?
3. Which of the moderators identified in 2.1.5 predict differences in the threat mitigation process?

Using different modalities in two experimental studies, cultural symbols (and by extension, culture) were shown to be effective secure bases and aided in emotion regulation when the individual was under threat. Examining the results from both studies, it is fairly clear that the presence of cultural stimuli aided in threat mitigation and emotion regulation efforts. In study 1, the SCR of individuals did not increase after threatening images but only when cultural secure bases were also shown. In study 2, the neural activation of a region responsible for emotion regulation in similar conditions suggested that cultural stimuli were effective in reducing threats. Relating back to the conceptual model, these results suggested that there is a link between the cultural symbols processed by the IWM before affecting the CNS and PNS responses to threat.

However, the quest to identify specific areas in the brain and tie them together into one cohesive model proved to be less successful. On the overall, results did not identify many of the predicted areas as being involved in the attachment process. The presence of threat induced responses in the affective regions (e.g. amygdala, insula) and the presence of home cultural symbols induced responses in the dlPFC. This is a good start as it corresponds to parts of the conceptual model. However, the remaining parts linking cultural stimuli directly to the emotion regulation is less clear. There is also the possiblity that the paradigm was not ideal for identifying these areas or the model proposed is incomplete or incorrect in some places. As with other research involving neural activations, there is a limit to the amount of ground one study can cover. Future research can attempt to piece together what this research partly shed light on.

Several moderators were tested to examine their impact on the cultural attachment process. Due to the exploratory nature of the moderators and confounds, there were slight differences between the ones tested in each study. Additionally, the measurements for cultural attachment and parental/adult attachment were also different. As a result, it is difficult to compare many of the findings between studies. However, although need for cognitive closure significantly moderated the cultural attachment process in Study 1, no similar effect was found in Study 2. Due to the background that each sample was chosen from, some of the differences between the two studies could be a result of cultural differences. As more data is collected, the true nature of these moderators should be clearer. Additionally, the two studies also attempted to examine the effects of potential confounds and establish cultural attachment as a distinctive measure. The confounds tested (as can be seen from the conceptual model) included group identity (cultural identifications), familiarity, patriotism, the effects of mood, perceived racism, and acculturation stress. Many of these concepts could be closely related to the specific domains of cultural attachment but cannot replace cultural attachment.

There was not much success in tying the self-reported cultural attachment scales to actual changes in behaviour or neural activations. In both studies, there were not many significant relationships between the cultural attachment styles and the biological results. Additionally, the choice to use different scales in each study led to the shortcoming of not being able to compare the results from the scales. On top of that, SCR and fMRI can capture less conscious processes which might not be accurately reflected in self-reported scales. As this is not the main focus of this thesis, this is something that should be addressed in further studies. It is currently unknown if the structure of attachment styles would remain the same for cultural attachment or if the different styles of cultural attachment can be measured using a scale. However, the clear correlation between the anxiety measures of the attachment and cultural attachment scales hint at some form of consistency in the viewing of the self.

In the same vein, there was also not much success in finding ties between maternal attachment and cultural attachment. This could boil down to the usage of general images rather than specific images of closed ones or caregivers. In many studies (e.g. Singer's studies on pain perception), actual images of the spouses were used. This is something that future research examining neural systems governing maternal and cultural attachment should pay attention to. On top of that, other than NFC, there did not seem to be any consistent individual trait that affected the emotion regulation process of cultural attachment.

6.0.1 Limitations and Future Research

Based on the relatively robust results from the Chinese sample in study 2, there is initial evidence that individuals who were separated from their home culture seemed to benefit from cultural symbols more. This suggests that the separation from one's home culture might amplify the importance of the attachment bond. In order to test this meaningfully, future research should incorporate other types of threats as well as extend the scope of participant recruitment. In particular, threats to separation (such as the AAP or words relating to separation) also activate the defence system (Jonas et al., 2014). The experience of being involuntarily separated from a caregiver and one's home country can be viewed as being similar. An example of an ecologically valid study would be to examine the emotions of refugees who were forced to leave their home countries and later allowed to return.

As specific mediations could not be tested in this thesis, the mechanisms and process by which the threat is mitigated has yet to be clearly shown. In order to do so, a revised experimental design (possibly with different measurement parameters to cater for the time lag needed for a causal model) would include a causal model which examines clear mediations between the brain regions. This allows the testing of other parts in the conceptual model that could be involved in the process but difficult to capture in a complex contrast such as the one used in Study 2. For example, in Study 2, the affective regions (amygdala, insula, etc.) were activated during threat. However, these regions did not seem to differentiate between the different types of secure base images. Hence, there could be nuances that are not captured. Additionally, there are some parts of the suggested systems (such as the existence of a critical period or the process of memory formation) that require a longitudinal study of repeated experiences to test. A longitudinal study allows insight into the acquisition of attachment targets and the manner by which rewards are attached to these targets. A related direction that future studies can also take is to examine the memory retrieval process. When individuals are primed about their attachment targets, recollection of such attachment targets reward them and subsequently provide them with security. Examining intricacies in this process could prove useful in categorizing individuals into different attachment styles. Lastly, the reaction time measures in both studies were not affected by the experimental conditions. This could suggest that the threat mitigation process does not put a toll on the cognitive resources, making reaction time measures not useful in detecting these changes.

The reliance on the images has many obvious advantages for such studies but, naturally, there is also a trade-off leading to some limitations in the research design. Although the images were chosen to be representative of their respective categories and they were rated as such by participants in the experiments and by an external group of raters, there is still the possibility that the images do not invoke their respective associated cognitive network. Additionally, it is difficult to obtain a set of images that is equally representative to each and every individual. Similar to romantic attachment research, one direction that future research can take is to have individuals submit images which they think are the most representative (in romantic attachment, this is typically their spouse). However, that will also lead to problems of consistency between the visual parameters of the images. As humans are sensitive to visual parameters (such as colour combination, brightness, or clarity) of the image, controlling for that by using the same image is the approach in this thesis.

Another limitation is the potential habituation effects from participants after being repeatedly exposed to the same images. As individuals habituate to the images, their responses (neural and behavioural) are possibly tapered and more likely to be dampened. The duration of the experiment can also be a concern as participants might experience fatigue. Although the analysis (done by omitting the latter half of the experiment) presented in study 2 did not introduce any new results, this is an issue that future studies should pay attention to. If possible, a rest period should be put in place to split the experiment up into two parts.

The generalizability of this research due to its limited sample can also be called into question. Participants recruited in the experiments in this thesis were mostly students who have lived in one to two countries for most of their lives. It is difficult to know if this phenomenon extends to other individuals who are younger or old as well as other individuals who have a wider range of multicultural experiences. The restrictions placed on sample selection in this thesis was necessary in order to isolate and divide participants into clearly defined groups. However, in the current globalised world, individuals are better travelled and more experienced with other cultures which were previously separated by geographical boundaries. It is difficult to predict if the emotional bond between these individuals will remain strong or weaken in the presence of other experiences. Additionally, it is also difficult to predict how the emotional bonds between individuals and their home culture will evolve as they age as well. One of the future directions that research in this area can take is to examine the impact of multicultural experiences and age on cultural attachment.

Another limitation is the choice to define cultural boundaries by nationality. Despite this being a popular choice in most cultural studies, many scholars have warned about equating nationality to culture (e.g. Matsumoto and Juang, 2016) and about the difficulty in pinning down the amorphous nature of culture (Taras et al., 2009). Although cognisant to the differences, I drew boundaries using nationality to allow for easier recruitment of a larger group of participants who were more likely to still have homegeneous experiences about the cultural group. Although there is no effect of nationalistic patriotism on the dependent variables in the studies, it is still tricky to label the emotional bond described in this thesis as cultural attachment without any doubt. One of the directions that future research can do is to examine cultural groups which are not defined by national or geographical boundaries. An example would be the brand culture whereby individuals identify themselves by the brands they consume and the beliefs that those brands represent. It is entirely possible that strong brands have their own cultural following which could have an impact on the emotion and well-being of its followers.

Another future direction of research should definitely be investigating the presence of a critical period of the acquisition of culture and the development of the cultural attachment bond. In the study of childhood attachment, age is a convenient proxy that is strongly correlated with brain development so using age as a benchmark for a critical period is fitting. However, more understanding about cultural learning patterns is needed before the same can be said for cultural attachment. In this thesis, it was assumed that young individuals who have not been exposed to different cultures deeply should have a fairly stable model of their own culture. In addition, young adults are more capable of understanding cultural symbols as compared to younger children. More research might reveal better measurements in this area.

Despite the basic nature of this research, there are some practical implications which arise from this. The first point revolves around the importance of symbolism in cultural groups. In this thesis, the mere exposure of cultural symbols was able to mitigate effects of threat. This reinforces the importance of having identifiable symbols and the association of experiences within a cultural group to those symbols. Although the cultural group used here is a national one, many other arbitrarily defined cultural groups can also benefit from having clear and strong symbols. Some notable examples include luxury brands, sports teams, or even schools. Future research should examine possible attachment bonds to these other cultural groups. A field study of a real stressful event or environment could go a long way in uncovering the viability of cultural symbols as potential long term solution in threat mitigation.

Despite the flaws with the research design and studies, this thesis extends research of cultural attachment, culture, and attachment in a desirable direction. The most important contribution of this thesis is to show converging multimodal evidence of SCR and BOLD activations which extends what anthropological and psychological research has suggested for a long time by providing an unprecedented perspective on the biological impact of culture on the individual. Not only does this validate the argument that attachment bonds can be formed with culture, it also provides an alternative avenue for researchers to measure the impact of culture on individuals. Also, this research attempts to answer calls to use cultural and cross-cultural research to improve the emotional and physical wellbeing of individuals (e.g. Chiao et al., 2015). It would also be interesting to examine if cultural symbols are used as coping mechanisms when other coping mechanisms are not present. This would be similar to research showing that religion can be used as a coping mechanism Chang et al. (1998); Yeh et al. (2006); Rodríguez-Galán and Falcón (2018). Additionally, in recent years, researchers have highlighted the importance of the role of affect and emotion in the study of culture Damasio (2018); Christopoulos and Tobler (2016). Currently, there is limited biological research linking the emotional states of individuals in the formation, maintenance and interaction of cultures. Naturally, the work presented in this thesis is in its first steps and more follow up work needs to be done.

6.0.2 Conclusion

All in all, the research presented in this thesis presents a first look at the neurobiological mechanisms of cultural attachment. It also highlights the involvement of affective and cognitive processes in the conceptualisation of culture and its abstract representation. I hope the work in this thesis can spark off a fruitful discussion of the culture-agent dyad, the attachment bond between them, as well as the different cultural groups that this research can apply to. Of course, the regret with the studies conducted, as with many experimental studies, is the conscious trade-off between experimental control and ecological validity. Ideally, complementary field studies can be conducted to make the results of this thesis even more robust.

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Appendix A: Questionnaires Used

Cultural Attachment Dimensional Scale (Svetlana, Higgins, & Hong, 2016)

Cultural Attachment Categorical Scale (Hong et al., 2013)

Cultural Identifications (Hong et al., 2013)

Experiences in Close Relationships Scale (Brennan et al 1998)

Parental Bonding Instrument (Parker et al., 1979)

Need for Cognitive Closure (Roets & van Hiel, 2011; orig Webster & Kruglanski, 1994)

Racial Essentialism (No et al., 2008)

Patriotism (Huddy & Khatib, 2007; Kosterman & Feshbach, 1989)

Perceived Racism Scale (McNeilly et al., 1996)

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1998)

Self-Rating Depression Scale (Zung, 1965)

Demographics

Post Experimental Rating of Stimuli

Cultural Attachment Dimensional Scale (Svetlana, Higgins, & Hong, 2016)

Note: Any instances of "Singaporeans" can be replaced with another nationality or cultural group. In this thesis, other nationalities used are "Americans" and "Chinese". Items with an R superscript are reversed scored.

This scale is used to measure cultural attachment on a 6-point Likert's Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Slightly Disagree, 4 = Slightly Agree, 5 = Agree, 6 = Strongly Agree). Security (belonging) sub-scores are calculated by using the average scores of items 1, 2, 3, 4. Insignificance sub-scores are calculated by using the average scores of items 5, 6, 7, 8. Boundarylessness sub-scores are calculated by using the average scores of items 9, 10, 11, 12. Sacredness sub-scores are calculated by using the average scores of items 13, 14, 15, 16.

We are interested in your attitudes towards your country of origin. The "Home country" in the items below refers to your country of origin.

1. My Home country provides support for my family and me.
2. My Home country cares for my family and me.
3. My Home country nurtures my family and me.
4. I feel I can always count on my Home country, whether I am home or abroad.
5. I feel ordinary people in this country are invisible to their Home country.
6. I feel my problems and me are too small, too insignificant, for my Home country.
7. Sometimes I feel I am too small to be count in my Home country.
8. No ordinary person can change something in my Home country. It is too big and powerful.
9. We are all citizens of this world; the concept of Home country in the 21st century is overrated.
10. I see myself as more cosmopolitan than as a patriot.
11. I feel at home at any place where my friends and family are, and it doesn't matter to me which country I am in.
12. I would raise my children in any place that provides them with nurturing and safe environment, and it doesn't matter to me what country it is.
13. I believe people should fully accept everything about their Home country.
14. I am afraid to think in bad terms about my Home country's past.
15. I despise people who criticize their Home country.
16. My greatest fear is to be abandoned - a person without a Home country.

Cultural Attachment Categorical Scale (Hong et al., 2013)

This scale is used to measure cultural attachment on a 5-point Likert's Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree Nor Disagree, 4 = Agree, 5 = Strongly Agree). Anxiety sub-scores are calculated by using the average scores of items 1, 2, 5, 7, 9, 11^R, 13, 16, 17, and 19. Avoidance sub-scores are calculated by using the average scores of items 3^R, 4, 6^R, 8, 10, 12^R, 14^R, 15^R, 18^R, and 20^R.

People may form attachment (emotional bonding) to different cultural groups. In the following, we would like to assess your attachment to <u>Singaporeans</u> in general. Respond to each statement by choosing the option on the right to indicate how much you agree or disagree with the statement. There is no correct or wrong answer. We would like to know your true feelings.

1. I am afraid that I will lose the friendship of Singaporeans.
2. I often worry that the Singaporeans around me will not want to be friends with me.
3. I feel comfortable sharing my private thoughts and feelings with the Singaporeans around me.
4. I find it difficult to allow myself to depend on Singaporeans
5. I worry that my Singaporean friends or coworkers won't care about me as much as I care about them.
6. I am very comfortable being close to Singaporeans.
7. I worry a lot about my relationships with the Singaporeans around me.
8. I don't feel comfortable opening up to Singaporeans.
9. When I show my feelings for the Singaporeans around me, I'm afraid they will not feel the same about me.
10. I get uncomfortable when a Singaporean wants to be very close.
11. I don't worry about being rejected by the Singaporeans around me.
12. It is not difficult for me to get close to other Singaporeans.
13. I find that the Singaporeans around me don't want to get as close as I would like.
14. I usually discuss my problems and concerns with Singaporean friends.
15. It helps to turn to Singaporeans in times of need.
16. My desire to be very close sometimes scares away the Singaporeans around me.
17. I'm afraid that once a Singaporean gets to know me, he or she won't like who I really am.
18. I talk things over with my Singaporean friends.
19. It makes me mad that I don't get the friendship and support I need from the Singaporeans around me.
20. I feel comfortable depending on Singaporeans.

Cultural Identifications (Hong et al., 2013)

This scale is used to measure cultural identifications on a 7-point Likert's Scale (1 = Not at all Like Me, 2 = Not Like Me, 3 = Not Much Like Me, 4 = Neutral, 5 = Somewhat Like Me, 6 = Like Me, 7 = Extremely Like Me). A composite score is calculated using the average scores of all items.

To what extent do the statements below describe you?

1. I connect with Singaporean culture.
2. I endorse with Singaporean culture.
3. I like Singaporean culture.
4. I agree with Singaporean culture.
5. I feel that Singaporean culture is part of me.
6. I feel Singaporean cultural values influence my daily life.
7. I feel Singaporean culture is important to me.

Experiences in Close Relationships Scale (Brennan et al 1998)

This scale is used to measure adult attachment on a 5-point Likert's Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree Nor Disagree, 4 = Agree, 5 = Strongly Agree). Anxiety sub-scores are calculated by using the average scores of items 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22[R], 24, 26, 28, 30, 32, 34, and 36. Avoidance sub-scores are calculated by using the average scores of items 1, 3[R], 5, 7, 9, 11, 13, 15[R], 17, 19[R], 21, 23, 25[R], 27[R], 29[R], 31[R], 33[R], and 35[R].

The statements below concern how you feel in emotionally intimate relationships. We are interested in how you generally experience relationships, not just in what is happening in a current relationship. Respond to each statement by choosing the option on the right to indicate how much you agree or disagree with the statement. There is no correct or wrong answer. We would like to know your true feelings.

1. I prefer not to show a partner how I feel deep down.
2. I worry about being abandoned.
3. I am very comfortable being close to romantic partners.
4. I worry a lot about my relationships.
5. Just when my partner starts to get close to me I find myself pulling away.
6. I worry that romantic partners won't care about me as much as I care about them.
7. I get uncomfortable when a romantic partner wants to be very close.
8. I worry a fair amount about losing my partner.
9. I don't feel comfortable opening up to romantic partners.
10. I often wish that my partner's feelings for me were as strong as my feelings for him/her.
11. I want to get close to my partner, but I keep pulling back.
12. I often want to merge completely with romantic partners, and this sometimes scares them away.
13. I am nervous when partners get too close to me.
14. I worry about being alone.
15. I feel comfortable sharing my private thoughts and feelings with my partner.
16. My desire to be very close sometimes scares people away.
17. I try to avoid getting too close to my partner.
18. I need a lot of reassurance that I am loved by my partner.
19. I find it relatively easy to get close to my partner.
20. Sometimes I feel that I force my partners to show more feeling, more commitment.
21. I find it difficult to allow myself to depend on romantic partners.
22. I do not often worry about being abandoned.
23. I prefer not to be too close to romantic partners.
24. If I can't get my partner to show interest in me, I get upset or angry.
25. I tell my partner just about everything.
26. I find that my partner(s) don't want to get as close as I would like.
27. I usually discuss my problems and concerns with my partner.
28. When I'm not involved in a relationship, I feel somewhat anxious and insecure.
29. I feel comfortable depending on romantic partners.
30. I get frustrated when my partner is not around as much as I would like.
31. I don't mind asking romantic partners for comfort, advice, or help.
32. I get frustrated if romantic partners are not available when I need them.
33. It helps to turn to my romantic partner in times of need.
34. When romantic partners disapprove of me, I feel really bad about myself.
35. I turn to my partner for many things, including comfort and reassurance.
36. I resent it when my partner spends time away from me.

Parental Bonding Instrument (Parker et al., 1979)

This scale is used to measure parental attachment on a 4-point Likert's Scale (1 = Very Likely, 2 = Moderately Likely, 3 = Moderately Unlikely, 4 = Very Unlikely). Care sub-scores are calculated by using the average scores of items 1, 2^{R}, 4^{R}, 5, 6, 11, 12, 14^{R}, 16^{R}, 17, 18^{R}, and 24^{R}. Overprotectiveness sub-scores are calculated by using the average scores of items 3^{R}, 7^{R}, 8, 9, 10, 13, 15^{R}, 19, 20, 21^{R}, 22^{R}, 23, and 25^{R}.

We are interested in various attitudes and behaviors of displayed by your parents. Please rate the following list of questions according to the memory of your FATHER in the first 16 years of your life.

1. Spoke to me in a warm and friendly voice.
2. Did not help me as much as I needed.
3. Let me do those things I liked doing.
4. Seemed emotionally cold to me.
5. Appeared to understand my problems and worries.
6. Was affectionate to me.
7. Liked me to make my own decisions.
8. Did not want me to grow up.
9. Tried to control everything I did.
10. Invaded my privacy.
11. Enjoyed talking things over with me.
12. Frequently smiled at me.
13. Tended to baby me.
14. Did not seem to understand what I needed or wanted.
15. Let me decide things for myself.
16. Made me feel I wasn't wanted.
17. Could make me feel better when I was upset.
18. Did not talk with me very much.
19. Tried to make me feel dependent on him.
20. Felt I could not look after myself unless he was around.
21. Gave me as much freedom as I wanted.
22. Let me go out as often as I wanted.
23. Was overprotective of me.
24. Did not praise me.
25. Let me dress in any way I pleased.

Need for Cognitive Closure (Roets & van Hiel, 2011; orig Webster & Kruglanski, 1994)

This scale is used to measures an individual's need for cognitive closure on a 5-point Likert's Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree Nor Disagree, 4 = Agree, 5 = Strongly Agree). A composite score is calculated by using the average score of all items.

Please read each of the following statements carefully and rate how much you agree or disagree with each statement.

1. I don't like situations that are uncertain.
2. I dislike questions which could be answered in many different ways.
3. I find that a well ordered life with regular hours suits my temperament.
4. I feel uncomfortable when I don't understand the reason why an event occurred in my life.
5. I feel irritated when one person disagrees with what everyone else in a group believes.
6. I don't like to go into a situation without knowing what I can expect from it.
7. When I have made a decision, I feel relieved.
8. When I am confronted with a problem, I'm dying to reach a solution very quickly.
9. I would quickly become impatient and irritated if I would not find a solution to a problem immediately.
10. I don't like to be with people who are capable of unexpected actions.
11. I dislike it when a person's statement could mean many different things.
12. I find that establishing a consistent routine enables me to enjoy life more.
13. I enjoy having a clear and structured mode of life.
14. I do not usually consult many different opinions before forming my own view.
15. I dislike unpredictable situations.

Racial Essentialism (No et al., 2008)

This scale is used to measures an individual’s need for cognitive closure on a 6-point Likert’s Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Mostly Disagree, 4 = Mostly Agree, 5 = Agree, 6 = Strongly Agree). A composite score is calculated by using the average score of all items. Items 4 to 8 are reversed scored.

People seem to have different opinions about what “race” is. Sometimes, their ideas about “race” could be quite abstract. We have collected a sample of people’s ideas below. We are interested in knowing how you think about these ideas. Please read through each statement carefully. Indicate your degree of agreement with each item by selecting one number to the right of each question.

1. To a large extent, a person’s race biologically determines his or her abilities and traits.
2. Although a person can adapt to different cultures, it is hard if not impossible to change the dispositions of a person’s race.
3. How a person is like (e.g., his or her abilities, traits) is deeply ingrained in his or her race. It cannot be changed much.
4. A person’s race is something very basic about them and it can’t be changed much.
5. Races are just arbitrary categories and can be changed if necessary.
6. Racial categories are constructed totally for economic, political, and social reasons. If the socio-political situation changes, racial categories will change as well.
7. Race does not have an inherent biological basis, and thus can be changed.
8. Racial categories are fluid, malleable constructs.

Patriotism (Huddy & Khatib, 2007; Kosterman & Feshbach, 1989)

This scale is used to measures patriotism on a 7-point Likert's Scale (1 = Not at all, 7 = Very Much). A composite score is calculated by using the average score of all items.

Please answer the following questions.

1. How important is being Singaporean to you?
2. To what extent do you see yourself as a typical Singaporean?
3. How well does the term Singaporean describe you?
4. When talking about Singaporeans, how often do you say "we" instead of "they"?
5. When you hear non-Singaporeans criticizing Singaporeans, to what extent do you feel personally criticized?
6. How good does it make you feel when you see the Singaporean flag flying?
7. How good does it make you feel when you hear the Singaporean anthem?

Perceived Racism Scale (McNeilly et al., 1996)

This scale is used to measures an individual's perception of racist behaviours towards him/her on a 5-point Likert's Scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = All of the Time). A composite score is calculated by using the average score of all items.

Below is a list of experiences, please indicate using the options on the right, how often each of these experiences has happened to you in the past year.

1. You have been called insulting names related to your race or skin colour.
2. When you go shopping, you are followed by security guards or watched by clerks.
3. You hear comments expressing surprise at your or other "minority" individuals' intelligence or industriousness.
4. People "talk down" to you because of your race.
5. You have experienced being followed, stopped or arrested by police more than others because of your race.
6. Waiters and waitresses ignore you and serve others first because of your race.
7. You have been refused rental housing which was then later rented to others of similar standing (e.g. comparable family income), because of your race.
8. You know of people who have gotten into trouble (gotten hurt, beaten up, shot) because of their race.
9. You have had difficulty getting a loan because you are Asian.
10. You have heard males of other races talk about not desiring Asian women for "serious" relationships versus those from their own race.
11. Your house has been vandalized because of your race.
12. You have had to allow others to obtain the best seats in public places because of your race.
13. You have been denied hospitalization or medical care because of your race.
14. You have encountered legal restriction against Asians, such as housing, marriage, jobs, use of public facilities.

Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1998)

This scale is used to measure the affect of the participant on a 5-point Likert's Scale (1 = Very slightly, 2 = A little, 3 = Moderately, 4 = Quite a bit, 5 = Extremely). Composite score for positive affect is calculated by using the average of items 1, 3, 5, 9, 10, 12, 14, 16, 17, and 19. Composite score for negative affect is calculated by using the average of the remaining items which are 2, 4, 6, 7, 8, 11, 13, 15, 18, and 20.

This scale consists of a number of words that describe different feelings and emotions. Please read each item and then circle the appropriate response. Use the following scale to indicate to what extent you feel this way RIGHT NOW, TODAY. There is no right or wrong answer. Please work as quickly as possible.

1. Interested
2. Distressed
3. Excited
4. Upset
5. Strong
6. Guilty
7. Scared
8. Hostile
9. Enthusiastic
10. Proud
11. Irritable
12. Alert
13. Ashamed
14. Inspired
15. Nervous
16. Determined
17. Attentive
18. Jittery
19. Active
20. Afraid

Self-Rating Depression Scale (Zung, 1965)

This scale is used to measure acculturation stress on a 4-point Likert's Scale (1 = A little of the time, 2 = Some of the time, 3 = Good part of the time, 4 = Most of the time). A composite scores is calculated using the average score of all items. Items 2, 5, 6, 11, 12, 14, 16, 17, 18, and 20 are reversed scored.

Please read each statement and decide how much of the time the statement describes how you have been feeling during the past several days.

1. I feel downhearted and blue
2. Morning is when I feel the best
3. I have crying spells or feel like it
4. I have trouble sleeping at night
5. I eat as much as I used to
6. I still enjoy sex
7. I notice that I am losing weight
8. I have trouble with constipation
9. My heart beats faster than usual
10. I get tired for no reason
11. My mind is as clear as it used to be
12. I find it easy to do the things I used to do
13. I am restless and can't keep still
14. I feel hopeful for the future
15. I am irritable than usual
16. I find it easy to make decisions
17. I feel that I am useful and needed
18. My life is pretty full
19. I feel that others would be better off if I were dead
20. I still enjoy the things I used to do

Demographics

1) What is your age?

2) What is your gender? Male/Female

3) Please indicate the highest level of education you have completed:

a) Some high school
b) High school diploma or equivalent
c) Some college or associate degree
d) B.A./B.Sc.
e) M.A./M.Sc./M.B.A.
f) M.D./J.D./Ph.D.

4) Please indicate your current yearly household income:

a) below USD$20,000
b) USD$20,000-35,000
c) USD$35,000-50,000
d) USD$50,000-75,000
e) USD$75,000-100,000
f) above USD$100,000

5) Indicate your political views on a) Foreign Policy, b) Economics Issues, and c) Social Policy Issues.

a) Very Liberal
b) Liberal
c) Slightly Liberal
d) Middle of the Road
e) Slightly Conservative
f) Conservative
g) Very Conservative

6) What is your religion?

7) How important is religion in your life?

a) Not at all Important
b) Very Unimportant
c) Somewhat Unimportant
d) Neither Important nor Unimportant
e) Somewhat Important
f) Very Important
g) Extremely Important

Multicultural Exposure

1) How often are you exposed to a culture other than the mainstream American culture? (1 = Never, 7 = Very Often)

2) Were you born in United States?

3) If you were not born in US, where were you born?

4) How old were you when you moved to US?

5) Overall, how long have you lived in US

6) Overall, how long have you lived in countries outside of the US?

7) Where was your mother born?

8) Where was your father born?

9) Are you a native English speaker?

10) What other languages can you speak?

11) What is the ethnicity of your five closest friends (e.g. classmates, personal friends etc)?

12) What type of cuisine do your five favourite restaurants/eating places serve (e.g. American, Korean, Chinese, Mexican etc.)

13) Which country does each of your five favourite musicians/musical groups come from?

Post Experimental Rating of Stimuli

For Chinese and American stimuli:

1) How Chinese is this image?

2) How American is this image?

3) How attractive is this image?

4) How connected are you to the objects in this image?

For Singaporean stimuli:

1) How Chinese is this image?

2) How American is this image?

3) How attractive is this image?

4) How connected are you to the objects in this image?

5) How Singaporean is this image?

Appendix B: Phone Screening Protocol

The following in the phone screening protocol used to recruit participants for Study 2.

Study: ______________ Date: / / ☐ Exclusion: ________________ ☐ OK to schedule
☐ Scheduled:_______________ ☐ Follow up 1st attempt:_____________ ☐ Follow up 2nd attempt:_________________

Phone Screening for IRB 14-685

Hi, this is (name) from Virginia Tech Carilion Research Institute. You recently contacted us about MRI study we're doing. Do you have a few minutes so I can tell you about the study and ask a few questions?

IF NO: clarify and remove from list as necessary
IF YES: continue:

Name:________________________________ Phone:________________________________

Email:________________________________

How did you hear about this study?____

Ok, let me just review briefly with you what the study involves. Currently, we are conducting studies to help us understand how people process and interpret peoples, icons, and symbols from different cultural and ethnic backgrounds. This study involves two parts; the first part of the study involves filling out questionnaires. This will last around one hour or so. For the second part, we might invite you to the lab to fill out more questionnaires and complete the brain imaging session(s). Only those who meet certain criteria will be asked to complete the second part. The imaging session will involve playing simple computer games or rating different pictures and symbols during an MRI scan. I do need to let you know of some potential risks regarding the tasks that you will be doing. These risks include viewing some images that might be emotionally arousing, disgusting, or aversive, for example, insects, spoiled food or bodily fluids. However, these images will not deviate from the types of objects and contaminants that people may typically encounter in everyday life or would see on films or TV. Also, you might be asked to make judgments about different faces and discuss your experiences with another culture. However, you should let us know if you think that you would not be comfortable with experiencing such images, making such judgments, or discussing these experiences. All information that you give us will be de-identified and password protected, and stored on computers in secure offices.

The MRI procedure is standard, completely non-invasive, and not painful. There are no known health risks. We'll be looking at what your brain is doing while you play the games. For answering questionnaires, you will be compensated $10 and it should take approximately one hour. If you are invited in for the MRI scan, you will be compensated $40 and this will last an hour to an hour and a half. If you are receiving SONA credit, you will receive one credit for the questionnaires and two credits for the scanning session.

We take confidentiality very seriously and all information you give us over the phone or in person will be kept confidential. Again, we replace any identifying information with a number and keep study materials in a locked cabinet.

Does the study sound like something you'd be interested in? **YES / NO**

IF YES: Great! Thank you. For this study, we are looking for a very specific group of people. Many people who call do not fit our criteria, but I can only check this by asking you some questions. If we can't find a good fit right now, may I keep you on the list for our future studies? **YES / NO**
There are a few first questions that will help us determine whether you may be eligible for the study:

1. Where were you born? ___________________________________

2. What ethnicity are you parents? ____

3. Have you spent more than 2 consecutive weeks outside of the U.S.? YES/NO
IF YES: Where?____

4. Have you ever been hospitalized for a medical reason?   YES / NO

YES: What was that hospitalization for?_______________________________________

When was that? ____

5. Do you have any medical problems?   YES / NO

YES: List problems ____

6. Are you currently taking any medications? YES / NO

YES: Medications and dosages: ____

What are these medications for? ____

7. Have you been diagnosed by a physician with any psychiatric problems? YES / NO

YES: Diagnosis and Date:____

8. Have you ever had a head injury or lost consciousness? YES/ NO

YES: Please explain: ____

How long were you unconscious for? (*Was is greater than 10 min?*) ______________________________

9. Have you had problems with alcohol or drugs in the past year? YES/NO

YES: What kind of abuse? ___________   Did you receive treatment? **YES/ NO**

10. Have you ever had seizures? YES/NO

When? ______________________________________ Were you medicated? **YES/NO**

11. Have you ever had problems with gambling? YES/NO

IF Not Eligible—
Thank you for completing the screening questionnaire. Upon reviewing your screening, we regret to inform you that you do not meet eligibility requirements for this study. This is because the specific study requires a specific set of different criteria; thus the fact that you are not eligible for this specific study is not indicative of your health status, intelligence, capabilities etc. Although you may not meet the specific requirements for the current study, you may still be eligible for future studies that investigate different research questions and have different eligibility criteria. We thank you for your participation in the screening questionnaire and for your interest in our study. We hope you will seek opportunities to participate in future studies conducted in our lab.

Appendix C: Results from Study 1 (including all participants)

The following tables show the results for Study 1 **without** excluding participants who did not register sufficient trials with valid ISCR while under threat.

Table C.1: *Linear mixed effects models of ISCR (Main effects of experimental conditions) with controls and all subjects included*

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.033***	.033***	.032***	.040***
	(.004)	(.005)	(.005)	(.010)
Threat		.006*		
		(.003)		
Secure Base			.003	
			(.003)	
log(Reaction Time)				−.020
				(.028)
Observations	1,976	1,976	1,976	1,976
Log Likelihood	2,799.266	2,798.856	2,796.135	2,796.726
Akaike Inf. Crit.	−5,584.532	−5,573.712	−5,568.270	−5,569.453
Bayesian Inf. Crit.	−5,545.410	−5,506.646	−5,501.204	−5,502.387

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01
Models (1) to (4) are in the form of: ISCR $\sim$ DV + (DV|Participant/Block) + (log(Onset Time)|Participant) where DV(1)=1; DV(2)=Threat; DV(3)=Secure Base; DV(4)=Reaction Time.

Table C.2: *Linear mixed effects models of ISCR (Main effects of individual differences) with controls and all subjects included*

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.033***	.034***	.034***	.027***
	(.004)	(.004)	(.005)	(.004)
CA-Security	−.004**			
	(.002)			
CA-Insignificance		.001		
		(.001)		
CA-Boundarylessness			−.0001	
			(.001)	
CA-Sacredness				−.003*
				(.002)
Observations	1,976	1,976	1,976	1,976
Log Likelihood	2,796.854	2,793.909	2,795.181	2,800.132
Akaike Inf. Crit.	−5,569.707	−5,563.817	−5,566.362	−5,576.264
Bayesian Inf. Crit.	−5,502.642	−5,496.751	−5,499.296	−5,509.198

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01

Models (1) to (4) are in the form of: ISCR ∼ DV + (DV|Participant/Block) + (log(Onset Time)|Participant) where DV(1)=CA–Security; DV(2)=CA–Insignificance; DV(3)=CA–Boundarylessness; DV(4)=CA–Sacredness.

Table C.3: *Linear mixed effects models of ISCR (Main effects of individual differences) with controls and all subjects included*

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.034***	.033***	.034***	.031***
	(.004)	(.005)	(.004)	(.004)
Paternal Care	.0004			
	(.001)			
P Overprotection		−.0003		
		(.001)		
Maternal Care			.001	
			(.001)	
M Overprotection				.001
				(.001)
Observations	1,976	1,976	1,976	1,976
Log Likelihood	2,793.527	2,793.827	2,796.317	2,794.850
Akaike Inf. Crit.	−5,563.054	−5,563.653	−5,568.633	−5,565.701
Bayesian Inf. Crit.	−5,495.988	−5,496.587	−5,501.567	−5,498.635

Standard errors are in parentheses. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$
Models (1) to (4) are in the form of: ISCR $\sim$ DV + (DV|Participant/Block) + (log(Onset Time)|Participant) where DV(1)=Paternal Care; DV(2)=Paternal Overprotection; DV(3)=Maternal Care; DV(4)=Maternal Overprotection.

Table C.4: *Linear mixed effects models of ISCR (Main effects of individual differences) with controls and all subjects included*

	Dependent variable:			
	Integrated Skin Conductance Response			
	(1)	(2)	(3)	(4)
Intercept	.034***	.034***	.034***	.031***
	(.007)	(.004)	(.005)	(.005)
Sex	−.0001			
	(.009)			
Patriotism		−.0005		
		(.001)		
Racial Essentialism			−.002	
			(.007)	
Need for Cognitive Closure				−.022**
				(.009)
Observations	1,976	1,976	1,976	1,976
Log Likelihood	2,795.894	2,793.438	2,801.860	2,804.911
Akaike Inf. Crit.	−5,567.787	−5,562.876	−5,579.721	−5,585.822
Bayesian Inf. Crit.	−5,500.721	−5,495.810	−5,512.655	−5,518.756

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01

Models (1) to (4) are in the form of: ISCR ∼ DV + (DV|Participant/Block) + (log(Onset Time)|Participant) where DV(1)=Sex; DV(2)=Patriotism; DV(3)=Racial Essentialism; DV(4)=Need for Cognitive Closure.

Table C.5: *Linear mixed effects models of ISCR (Two-way interaction of experimental conditions) with controls and all subjects*

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.036***
	(.005)
Threat	.001
	(.004)
Secure Base	$-$.003
	(.004)
Threat*Secure Base	.012**
	(.005)
Observations	1,976
Log Likelihood	2,795.346
Akaike Inf. Crit.	$-$5,550.692
Bayesian Inf. Crit.	$-$5,438.916

Standard errors are in parentheses. *p$<$0.1; **p$<$0.05; ***p$<$0.01
The model used here is: ISCR $\sim$ Threat*Secure Base + log(Onset Time) + (Threat + Secure Base|Participant/Block) + (log(Onset Time)|Participant).

Table C.6: *Linear mixed effects models of ISCR (Three way interaction with Threat/Secure Base) with controls and all subjects*

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.036***
	(.005)
Threat	−.0002
	(.004)
Secure Base	−.004
	(.004)
CA-Insignificance	.001
	(.002)
Threat*SecureB	.013**
	(.005)
Threat*CA-Insig	−.002
	(.001)
SecureB*CA-Insig	−.001
	(.001)
Threat*SecureB*CA-Insig	.003*
	(.002)
Observations	1,976
Log Likelihood	2,775.299
Akaike Inf. Crit.	−5,486.598
Bayesian Inf. Crit.	−5,307.756

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
The model used here is: ISCR $\sim$ Threat * Secure Base * CA–Insignificance + log(Onset Time) + (Threat + Secure Base + CA–Insignificance|Participant/Block) + (log(Onset Time)|Participant).

Table C.7: *Linear mixed effects models of ISCR (Three way interaction with Threat/Secure Base) with controls and all subjects*

	Dependent variable:
	Integrated Skin Conductance Response
Intercept	.032***
	(.005)
Threat	−.0001
	(.004)
Secure Base	−.003
	(.004)
NFC	−.020**
	(.010)
Threat*SecureB	.012**
	(.006)
Threat*NFC	−.007
	(.008)
SecureB*NFC	−.0003
	(.007)
Threat*SecureB*NFC	.008
	(.009)
Observations	1,976
Log Likelihood	2,786.451
Akaike Inf. Crit.	−5,508.901
Bayesian Inf. Crit.	−5,330.059

Standard errors are in parentheses. *p<0.1; **p<0.05; ***p<0.01
The model used here is: ISCR ∼ Threat * Secure Base * Need For Cogntive Closure + log(Onset Time) + (Threat + Secure Base + Need For Cogntive Closure|Participant/Block) + (log(Onset Time)|Participant).