Neural underpinnings of dynamic in-groups and out-groups based on ethnicity and culture in multicultural societies

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**NEURAL UNDERPINNINGS OF DYNAMIC IN-GROUPS AND OUT-
GROUPS BASED ON ETHNICITY AND CULTURE IN MULTICULTURAL
SOCIETIES**

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A Thesis Submitted to the Nanyang Technological University

In Fulfillment of the Requirement for the Degree of

Master of Arts

2019

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I certify that all work submitted for this thesis is my original work. I declare that no other person's work has been used without due acknowledgement. Except where it is clearly stated that I have used some of this material elsewhere, this work has not been presented by me for assessment in any other institution or University. I certify that the data collected for this project are authentic and the investigations were conducted in accordance with the ethics policies and integrity standards of Nanyang Technological University and that the research data are presented honestly and without prejudice.

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Table of Contents

	Page
Statement of Originality.....	II
Supervisor Declaration Statement.....	III
Acknowledgements.....	IV
Table of Contents.....	V
List of Figures.....	VII
List of Tables.....	VIII
Abstract.....	IX
Chapter I: Introduction.....	1
Chapter II: Literature Review.....	6
Neural Substrates of in-group and out-groups using faces.....	6
Fusiform gyrus.....	6
Superior temporal sulcus.....	7
Theory of mind/mentalizing networks.....	8
<i>Temporoparietal junction</i>	8
<i>Lingual gyrus</i>	8
<i>Somatosensory cortices</i>	8
<i>Supramarginal gyrus</i>	9
Amygdala.....	10
Anterior cingulate.....	10
Insula.....	11
The effect of culture.....	11
Chapter III: Current Study.....	12
Singapore as the Multicultural Society.....	12
In-groups and Out-groups in Ethnic and Cultural Contexts.....	14
Aim and Hypothesis.....	15
Relevance.....	17
Chapter IV: Methods.....	18
Participants.....	18
Experimental Task.....	18

Procedure.....	20
fMRI Data acquisition.....	20
fMRI Data analysis.....	21
Chapter V: Results.....	23
Typical and Non-typical ethnicities in Cultural and Ethnic Contexts.....	23
Neural Responses to In-group Faces in Cultural and Ethnic Contexts.....	23
Neural Responses to Out-group Faces in Cultural and Ethnic Contexts.....	25
Comparing Neural Responses of Out-groups and In-groups in Cultural Context.....	25
Comparing Neural Responses of Out-group and In-group in Ethnic Context.....	25
Chapter VI: General Discussion.....	27
Culture and Ethnic Contexts only affect Typical Ethnicities.....	27
Higher Social Cognition in Cultural Context.....	28
More Effort in Processing Out-group Faces in Ethnic Context, But No Out-group Activation.....	30
Enlarged In-group Present in Cultural Context.....	33
Implications.....	34
Limitations.....	35
Conclusion.....	37
References.....	42
Appendices.....	55

List of Figures

Figure 1.	Task paradigm.....	19
Figure 2A.	Brain activations to typical ethnicities in Singapore in cultural versus ethnic context.....	24
Figure 2B.	Brain activations to non-typical ethnicities in cultural versus ethnic context.....	24
Figure 3.	Brain activation of in-group Chinese faces in cultural context versus ethnic context.....	24
Figure 4A.	Significant difference in brain activation when viewing out-group faces versus in-group faces in the cultural context.....	26
Figure 4B.	Significant difference in brain activation when viewing out-group faces versus in-group faces in the ethnic context.....	26
Figure 5.	Graphical representation of a likely scenario of in- and out-group membership dynamics in Singapore.....	35

List of Tables

Table 1.	Sites of significant neural activation ($p < 0.05$, FWE correction) related to the contrasts <i>typical faces in CulCon</i> vs. <i>typical faces in EthCon</i> and <i>non-typical faces in CulCon</i> vs. <i>non-typical faces in EthCon</i>	39
Table 2.	Sites of significant neural activation ($p < 0.05$, FWE correction) related to the <i>IF in CulCon</i> vs. <i>IF in EthCon</i>	40
Table 3.	Sites of significant neural activation ($p < 0.001$, uncorrected) related to the contrast <i>OF in CulCon</i> vs. <i>OF in EthCon</i>	40
Table 4.	Sites of significant neural activation related to the contrast <i>OF in CulCon</i> vs. <i>IF in CulCon</i>	41
Table 5.	Sites of significant neural activation ($p < 0.05$, FWE) related to the contrast <i>OF in EthCon</i> vs. <i>IF in EthCon</i>	41

Neural Underpinnings of Dynamic In-groups and Out-groups based on Ethnicity and Culture in Multicultural Societies

Abstract

Integration between various ethnic groups is characteristic of multiculturalism. Beyond ethnicity, the social perception of others as either in-group or out-group is influenced by multilevel factors; one such factor is the interaction of ethnic groups in daily life. A common culture can be developed with strong exposure and personal contact among ethnic groups. Taking advantage of Singapore's highly integrated multicultural society, it is postulated that identifying with a common shared culture may drive an automatic and spontaneous sense of membership to a multi-ethnic group. Thus there would be an enlarged cultural in-group in addition to the ethnic in-groups and out-groups. There is a lack of understanding of affective and cognitive processes that influence the neural responses underlying the perception of others as members of in-groups and out-groups in multicultural societies. This study investigated neural reactivity and responsiveness to ethnic in-group (IF) and out-group faces (OF), and the modulatory effect of the environmental context in which one lives: ethnic-related contexts (ethnic monuments) versus cultural-related contexts (Singapore's well-known monuments); and also how the individuals' perception and attitudes, modulated by positive endorsement and promotion of multi-ethnic integration, can influence their cerebral responses. A total of 48 Chinese Singaporean participants underwent functional magnetic resonance imaging (fMRI) while viewing images of in-group Chinese faces and OF (Indian, Arabic, and Caucasian faces), primed with either cultural context or their relevant ethnical context. Greater sensitivity to contextual primes for typical ethnicities (Chinese and Indian faces)

present in Singapore, compared to non-typical ethnicities (Caucasian and Arabic faces) was found. Cultural context enhanced engagement of brain regions implicated in higher visual processing and social cognition; mainly the visual association area, mirror neuron networks, lingual gyrus, and temporoparietal networks, in order to make individuating judgments of people rather than superficial judgments based on group membership. Enhanced visual processing, mentalizing networks, and social perception networks were active for out-group face processing in the ethnic context, indicating more effort in perceiving out-groups faces instead of showing typical out-group neural responses. Finally there was no difference in neural responses to out-group and in-group faces in the cultural context, which was otherwise present in the ethnic context. This suggests that out-groups were treated like in-groups when a common shared culture was primed; enlarged cultural in-group. These findings verify that common shared culture, more than ethnicity, drives an automatic and spontaneous sense of membership to a multi-ethnic group when cross-cultural interaction is enhanced. These finding suggest a possible emergent phenomenon in multicultural societies, the development of a new way to categorize yourself and others, in terms of membership, which stands between the classical ethnic in- and out-group categorization. Findings also imply that successful efforts to enforce intergroup interaction have important effects that are reflected at a neural level beyond the mere exposure effect.

Chapter I: Introduction

This study investigated neural reactivity and responsiveness to ethnic in-group faces (IF) and out-group faces (OF) in a multicultural society and the modulatory, or influential effect of the ethnic and common shared cultural context in which one lives. This study also investigated how the individuals' perception and attitudes modulated by positive endorsement and promotion of multi-ethnic integration influenced their cerebral responses.

Due to rapid urbanization and globalization resulting in increasing levels of migration (Kærgård, 2010), many countries have people residing from various ethnic backgrounds resulting in ethnic diversity (Dijkstra, Geuijen, & De Ruijter, 2001; Holtug, 2016; Mahmud & Jahan, 2013; Keong, 2013). Many countries comprise of multicultural members or citizens. One of the main challenges of multicultural societies is to understand complex social interaction in order to ensure social cohesion and harmony (Dijkstra et al., 2001; Rosenthal & Levy, 2010).

People make sense of their complex social world through social categorization (Derks, Stedehouder, & Ito, 2014; Kaul et al., 2012; Van Bavel & Cunningham, 2010). People typically divide the social world into 'us' and 'them' (Shkurko, 2012; Van Bavel & Cunningham, 2010). The in-group and out-group opposition is the most typical way to represent group differences. People perceive themselves and other people they encounter as members of social categories based on similarities such as race, gender, age, nationality, etc (Derks et al., 2014; Van Bavel & Cunningham, 2010). People categorize themselves based on the salient social categories (Kurzban, Tooby, & Cosmides, 2001), some of which are automatically encoded (Kaul et al., 2012). For example, race affects perceptual processing within a few hundred milliseconds (Cunningham et al., 2012; Ito & Urland, 2003) and thus is one of the

most salient social categories. The in-group and out-group distinction based on social categorization initiates a wide range of positive and negative intergroup constructs, such as, intragroup cohesion, social identity, stereotypes, and prejudice (Derks et al., 2014).

In multicultural societies, the negative aspects of ethnic diversity are constantly addressed at community and political levels (Gijssberts, Van Der Meer, & Dagevos, 2011; Keong, 2013). Rosenthal and Levy (2010) summarize a multicultural approach that proposes social categorization based on race and ethnicity should be given attention, rather than de-emphasized or ignored, and understood in order to develop knowledge and respect for other groups. According to the authors multiculturalism is characterized by three central aspects: i) acknowledging differences between ethnic groups; ii) appreciation of each group's contributions made to society; and iii) an emphasis on groups' maintaining their own cultures and traditions (Rosenthal & Levy, 2010).

Such an approach to diversity is aligned with Singapore's stance of multiculturalism, where ethnic identities are encouraged to be preserved rather than eclipsed, so that ethnic groups may interact and co-exist in harmony. Citizens of Singapore are reckoned to identify with their racial ethnical identity as well as their national identity as Singaporeans (Salleh, 2017; StraitsTimes, 2017). The policies and positive attitudes towards multi-ethnic societies in Singapore to enhance social interaction and integration have lead to a common shared culture that all citizens can identify with regardless of their racial ethnic background. Hence, Singapore provides a suitable platform to study multi-group membership and its neural underpinnings.

In fact, people can be members of various groups simultaneously. In-group and out-group categorization depends on which categorization is salient (Hehman et

al, 2011; Katsumi & Dolcos, 2018). Social perception of other members as in-group or out-group is influenced not just by ethnicity, but also by multilevel factors: different facial features, emotional reaction to different social groups, and cognitive aspects such as the formal and informal social roles that drive relations between minority and majority ethnic groups in daily life (Elfenbein & Ambady, 2002; Soto & Levenson, 2009).

Research has shown that by shifting categorizations such that former out-group members are included within the in-group, intergroup conflict and bias can be reduced (Gaertner & Dovidio, 2000). Research has shown that members who belong to double in-groups (e.g. same race/same university) are preferred over members of partial in-groups (e.g. same race/different university), who are preferred over members of double out-groups (e.g. different race/different university)(Crisp & Hewstone, 1999; Hehman et al., 2011). Research has also shown that face-recognition of double in-group members were far greater than partial in-groups or double out-groups (e.g. Hehman et al., 2011). Double in-group faces had a larger event-related potential (ERP) component, followed by faces of partial in-groups, indicating greater neural processing in the attention networks (Hehman et al., 2011).

An abundance of research on face perception, processing, and recognition have been used to understand in-group and out-group perceptions and processes (e.g. Bavel, Parker, & Cunningham, 2008). This is mainly because faces provide important social cues. Particularly, faces provide information critical to social categorization (e.g., sex, race, age), emotional evaluation, and intentions. Faces can communicate information quickly and efficiently (Hugenberg & Wilson, 2013).

Since social categorization of members as in-group or out-group is dependent on the context (Turner et al., 1994), here we proposed that face processing of in-group

and out-group ethnicities will differ based on the context. Using Singapore as a multicultural platform for this study, and taking advantage of Singaporeans' ethnical and national identities we posit that neural responses to in-group and out-group faces would be different when people's ethnical identity is primed through ethnic context and when their national identity is primed through cultural context; that emulates a common shared culture. We further postulate that priming people with a common shared culture (i.e. cultural context), would drive an automatic and spontaneous sense of membership to a multi-ethnic group. That is, there will be an enlarged cultural in-group.

Studying neural responses towards in-group and out-group faces will present an unbiased reflection of in-group and out-group perception. Investigating neural responses to in-group and out-group social perceptions have gained ample attention (for review see Adolphs, 2001; Kubota, Banaji, & Phelps, 2012; Shkurko, 2012). Neural substrates involved in in-group and out-group social cognition using faces include visual attention networks such as the fusiform gyrus (FG), amygdala, self-regulatory and control areas such as anterior cingulate cortex (ACC), temporoparietal junction (TPJ), and the superior temporal sulcus (STS) (e.g. Adolphs, 2001; Kubota, Banaji, & Phelps, 2012; Shkurko, 2012).

This study is a pioneer study to investigate the modulatory effect of ethnic and cultural context on in-group and out-group face processing in a multicultural society and the neural underpinnings on an enlarged multi-ethnic in-group driven by a common culture. Until now there is a lack of knowledge on the dynamics that determine the ambiguous division between new emergent in-group and out-group categories, which drive a sense of membership. Singapore represents a special case that can help to shed light on new dynamics in multicultural social processes. The

implications of this study are vast. These findings may have an impact on how promoting a common shared culture may enhance social integration and interaction, reduce racial prejudice and conflict. Furthermore, findings from this study will enable us to understand complex social categorization processes in a multicultural society.

Therefore, taking advantage of Singapore's well-integrated multicultural setting, this study looked at how ethnic and cultural contexts shape brain responses to in-group and out-group faces in multicultural societies. This study also postulated that in a well-integrated multicultural society, identifying with a common share culture drives an automatic sense of membership to a multi-ethnic group, giving rise to an enlarged cultural in-group in addition to the usual ethnic in-groups and out-groups. Thus, this study also investigated the neural underpinnings of an enlarged cultural in-group. Since this study was conducted in a relatively well-integrated multicultural society, this study was also able to shed light on understanding how individuals' perception and attitudes modulated by positive endorsement and promotion of multi-ethnic integration influenced their cerebral responses.

Chapter II: Literature Review

The aim of this literature review was to list out important neural underpinnings of in-group and out-group face processing, social cognition, and culture in order to be able to understand the neural findings in this study.

Neural Substrates of in-group and out-groups using faces

Fusiform gyrus. The fusiform gyrus (FG) or the fusiform face area (FFA) is located on the ventral surface of the temporal lobe (Iidaka, 2014). It is associated with visual expertise that shows greater sensitivity to faces (Golby et al., 2001; Iidaka 2014; Shkurko, 2012). The fusiform gyrus is often implicated in social cognition experiments, owing to the use of human faces in many such experiments (Kubota et al., 2012; Shkurko, 2012). Activity of FG is reported when own-race faces or even subliminal in-group faces are processed (Van Bavel, Packer, & Cunningham, 2011). Heightened activity of the FG indicates deeper processing of in-group faces compared to out-group faces, as more neural resources are used to process these faces (Guassi Moreira, Van Bavel, & Telzer, 2016). FG plays an important role in individuating faces, that is, to identify the face as an individual entity rather than forming a general identity based on characteristics of its group membership. Lower FG activity may indicate failure to encode out-group members at the individual level, resulting in out-group members to be perceived as similar to each other than in-group members. This perceptual homogeneity of out-group members may contribute to negative implicit evaluations and even poor memory for racial out-group members (Kubota et al., 2012; Guassi Moreira et al., 2016).

FG activity is also reported for out-group activation (e.g. Ronquillo, 2010). This may be due to FG's involvement in top-down processing, other than its role in

bottom up processing in implicit social discrimination. In this case, FG may be activated when participant's attention is explicitly directed toward social differences or changing social context (Shkurko, 2012). Thus FG has a role in "the initial predisposition to social discrimination and indexing of socially significant perceptual input according to pre-existing expectancies and attention to particular aspects of social milieu", Shkurko (2012).

Superior temporal sulcus. Located at the lateral aspect of the temporal lobe is the superior temporal sulcus (STS; Iidaka, 2014). STS is also relatively selective for face stimuli and is involved in detection of gaze direction, prosody, facial expressions, and facial identity recognition tasks (Iidaka, 2012; Pitcher, 2014). Activation in the STS is also a neural signature for in-group favoritism (Molenberghs, 2013; Katsumi and Dolcos, 2017). Other than that, STS has a role in social attention; it has been implicated in cognitive empathy and perspective taking (Frith & Frith, 2006; Saxe & Kanwisher, 2003), detection of social cues, such as, trustworthiness and intention (Candidi, et al., 2015; Iidaka, 2012; Sturm, Haase, & Levenson, 2016). STS activity is also reported in pro-social (e.g. generosity) and altruistic behaviors, suggesting its role in the capability to understand and orientate focus on other people, leading to feelings and acts of selflessness (see Strum et al., 2016). This suggests a role of STS in theory of mind (ToM).

ToM or mentalizing refers to the ability of explaining and predicting other people's behavior through reading, reasoning, and representing their independent mental states (Gallagher and Frith, 2003; Freeman et al., 2010). ToM is implicated in social reasoning and individuating judgments of people. In fact, STS has been implicated in many tasks that require mentalizing/ToM or individuated judgments of people (see Eres & Molenberghs, 2013).

Theory of mind/mentalizing networks. Below are some ToM networks implicated in social cognition tasks other than the STS.

Temporoparietal junction. A popular region implicated for ToM is the temporoparietal junction (TPJ; Decety & Lamm, 2007; Shkurko, 2012). TPJ activation was found for tasks that required mentalizing (Adams et al., 2010; Falk et al., 2012; Rilling et al., 2008). TPJ is recruited differently for in-group and out-group members in various social contexts (see Shkurko, 2012).

Lingual gyrus. Individuating judgments of people, as opposed to superficial or stereotypical judgments, employs the social reasoning function of the mentalizing networks (Freeman et al., 2010). Lingual gyrus is implicated in individuating judgments of people; higher activation of the lingual gyrus was found during a task that required participants to make individuating judgments rather than superficial judgments (Freeman et al., 2010). Lingual gyrus is also implicated in self-face perception; greater lingual gyrus activation was found when participants viewed their own-faces (e.g. Scheepers et al, 2013). Lingual activation was also obtained during in-group face processing compared to out-group faces (e.g. Scheepers et al, 2013). This shows that the lingual gyrus may also have a role in self-referential social cognition (i.e. how similar or different a group is from the self).

Somatosensory cortices. The primary, secondary, and associative somatosensory areas are all involved in perception of social emotion (Adolphs, 1999; Han, 2015; Pourtois et al., 2004; Sugranyes et al., 2011). For example, the amount of monetary donation given to a real charitable organization was predicted by empathy related activity in the secondary somatosensory cortices (Han, 2015; Ma, Wang, & Han, 2011). Somatosensory cortices are implicated in the mirroring of emotional or internal states, in order to facilitate their recognition in oneself or other (Sugranyes et

al., 2011). Damage to somatosensory areas impairs performance on ToM tasks, where participants were required to reason about the mental states and beliefs of other individuals (Adolphs, 1999, 2001).

Supramarginal gyrus. Another region that is implicated in ToM is the supramarginal gyrus (SMG; Schurz, 2017). SMG is part of the inferior parietal lobule, which is involved in reorienting attention, self-perception, and social cognition (Igelström & Graziano, 2017). SMG activation is seen during self-face, in-group and even out-group activation (depending on the context and task) (Scheepers et al., 2013; Shkurko, 2012).

Amygdala. The principal function of amygdala is to link the perceptual representation of stimuli to cognition and behavior on the basis of social and emotional value (Adolphs, 2001). Amygdala activation is more frequent in out-group face perceptions (see reviews by Adolphs, 2001; Kubota et al., 2012; Shkurko, 2012). In humans amygdala is involved in the recognition of negative valence emotions, such as, fear (Adolphs, 2001; Kubota et al., 2012; Shkurko, 2012). Studies involving lesion or damage to amygdala in humans found subjects to perceive others as more trustworthy or approachable than normal subjects (Adolphs, Tranel, & Damasio, 1998). This offers an explanation to the implicit racial bias seen with amygdala activation to out-groups; out-groups may trigger amygdala activation due to possible threat detection and vigilance (e.g. Whalen, 1998).

Anterior cingulate. Different areas of the anterior cingulate cortex (ACC) are sensitive to out-group and in-group conditions. Dorsal AAC is implicated in out-group condition (see review by Kubota et al., 2012 and Shukurko, 2012). Activation in this region is observed during self-regulatory functions, especially when there is a conflict between pre-potent and intentional, deliberate responses (Kubota et al.,

2012). Dorsal ACC activation for out-group members is interpreted as conscious control and suppression of negative intentions in order to perceive or respond fairly in a socially acceptable manner (Kubota et al., 2012, Shukurko, 2012). The more ventral portions of the ACC are involved in in-group activations. Activity in these areas were associated with mentalizing others who were considered similar (Freeman et al., 2010; Gobbini et al., 2004), positive emotions during social comparison (Volz et al., 2009), and representation of self-relevant information (Harada, Li, & Chiao, 2010; Northoff et al., 2006; Shukurko, 2012).

Insula. Damage to insula is linked to failure to respond to any stimuli that represent something disgusting (Harris and Fiske, 2006) and difficulties avoiding risky decisions (Weller et al., 2009). Several studies report insular activation in response to racial out-groups, as well as political out-groups (Falk et al., 2012; Kaplan et al., 2007; Phelps et al., 2000; Richeson et al., 2003, 2008) and to unfamiliar faces (Gobbini et al., 2004). Given the function of insula, activation towards out-group conditions indicates avoidance behavior in social settings with uncertainty or danger (Shukurko, 2012).

The effect of culture

Studies have been conducted on the effect of culture on social emotional perception, such as, pain of others and emotion recognition. Findings from two noteworthy studies are discussed here in order to better understand the results of this study in the light of culture. Derntl et al. (2009) investigated the effect of culture on neural correlates of emotion recognition. They found significant cultural influence; there was higher emotional recognition accuracy of Caucasian actors by Europeans compared to Asians. Asians showed greater amygdala activation during the emotional recognition task, which reduced with longer period of stay in the respective foreign

country. Although this study explores the effect of cultural assimilation, it used two distinct groups to understand the effect of culture; one that belongs to the culture (i.e. Europeans), and the other group that is new to the culture (i.e. Asians). In this study, the effect of a common shared culture was investigated in the same group that also identified with their distinct ethnicities. Neural correlates of dynamic in-group and out-groups were investigated through a much general face processing paradigm rather than emotional recognition. Regardless, the study by Derntl et al. (2009) proves that cultural assimilation in a foreign country reduces the out-group-like phenomena (e.g. amygdala activation to out-groups).

Cognitive strategies and intergroup relationships can be manipulated in laboratory setting to reduce out-group racial bias towards empathic neural responses (see Zuo & Han, 2013). Zuo and Han (2013) investigated real-life exposure and experiences with members of racial out-groups and its impact on racial bias in empathic neural responses to others' suffering. They found no difference in neural activity of the pain matrix when Chinese participants, who were brought up in Western countries, saw videos of Asian models and Caucasian models receive painful stimulation. This study shows that pain perceptions of racial out-groups members were treated the same way as racial in-group members amongst individuals who have been acculturated to the culture of their out-group members. Again, although a similar pattern of results were expected in the current study, the current study looked at the effect of priming a common shared culture as well as ethnicity on neural responses to in-group and out-group faces. The study by Zuo and Han (2013) showed cultural experiences reduce out-group bias in pain perception, but does not look at how out-group and in-groups are perceived with such cultural experiences. In fact the current

study investigated the possibility of an enlarged cultural in-group that comprises of multi-ethnic members when a common shared culture is primed.

Chapter III: Current Study

This study aimed to understand the neural reactivity and responsiveness to ethnic in-group and out-group faces in a multicultural society and the modulatory effect of the ethnic and common shared cultural context in which one lives. This study also investigates how the individuals' perception and attitudes modulated by positive endorsement and promotion of multi-ethnic integration influenced their cerebral responses.

Harmonious multicultural societies consist of people from various racial ethnical backgrounds with overlapping, common culture that reflects on the extent of cross-ethnic and cross-cultural integration (Ålund, 1999; Allan, 2008; Dijkstra et al., 2001; Kearns & Whitley et al., 2018). The multicultural perspective towards ethnic diversity proclaims, "race and ethnicity should be given attention (rather than ignored) because prejudice develops in part from a lack of knowledge of and respect for other groups" (Rosenthal & Levy, 2010). Singapore's stance on multiculturalism is aligned with this idea where ethnic identities are encouraged to be preserved, rather than eclipsed, so that ethnic groups may interact and co-exist in harmony. Strong exposure to other ethnic groups living in the same country can promote the development of a common culture.

Singapore as the Multicultural Society

This study took advantage of Singapore's multicultural attitudes to achieve the abovementioned aims. Singapore's main racial make-up encompasses the "CMIO" classification: Chinese, Malay, Indian, and Others. The government of Singapore took up various efforts to ensure social cohesion in order to foster a society that now Singapore's Prime Minister Lee Hsien Loong refers to as a "society where each race

is encouraged to preserve its unique culture and traditions and appreciate and respect that of others” (StraitsTimes, May 2017).

Singapore governments’ approach to the conundrum of multiculturalism, to promote and enhance social integration and cohesion, was to allow for ethnicities to preserve their identities and also develop a common shared ‘Singaporean’ culture through various efforts. To mention a few, the ruling party of Singapore officialized languages of the main racial groups in Singapore in addition to English, but also ensured everyone had to learn English as a common language (Constitution of the Republic of Singapore, 2018). The Ethnic Integration Policy was introduced in 1989 to set a quota for each ethnic group in the Housing and Development Block (HDB) estates in order to avoid racial clustering and maintain the ethnic balance in the public residential estates (HDB, 2017). Law and the political system in Singapore are reflective of its multicultural nature to ensure minority beliefs are integrated into the law and minority ethnicities are represented in the parliament (Keong, 2013; National Library Board, 2013). The Maintenance of Religious Harmony Act (MHRA) was introduced in 1990 to ensure religion was not exploited for political purposes or vice versa (Lim, 2010). Grassroots organizations, community development councils, schools etc., celebrate racial Harmony Day every year on 21st July to commemorate the importance of maintaining racial harmony in a multicultural setting of Singapore (National Library Board, 2014).

These various policies implemented to facilitate social integration and cohesion amongst various ethnicities in Singapore has been relatively efficacious. In a survey conducted by Mathew et al. (2017), Singaporeans were more accepting of new citizens as “true Singaporeans” if they came from the traditional Chinese, Malay, or Indian backgrounds. Singaporeans also identified to a greater extent with each other’s

ethnic cultures compared to other cultures (Mathew et al., 2017). One plausible limitation to the extent of multi-ethnic or multicultural integration was seen when Singaporeans reported relatively lesser acceptance towards new citizens coming from non-typical Singaporean ethnic background, such as, Arabic or African backgrounds (Mathew et al., 2017).

Overall, many policies have been implemented to facilitate racial harmony amongst the typical ethnicities in Singapore resulting in the development of a common shared culture giving rise to a Singaporean cultural identity in addition to their ethnical identity (Mathews et al., 2017). Therefore Singapore poses as an appropriate multicultural platform to study the effect of ethnic and cultural context on neural responses to ethnic in-group and out-group faces.

In-groups and Out-groups in Ethnic and Cultural Contexts

People are members of various groups simultaneously (Hehman et al, 2011). In addition to the ethnic in-groups and out-groups, we posit that identifying with a common shared culture may drive an automatic and spontaneous sense of membership to a multi-ethnic group, establishing a larger cultural in-group.

In-group and out-group categorization is fluid and context dependent (Turner et al., 1994). Categorization of members as in-group and out-group may change depending on which categorization is more significant or salient (Hehman et al, 2011; Katsumi & Dolcos, 2018; Turner et al., 1994), or depending on the individual's socio-cognitive goal (Wheeler and Fiske, 2005). In this study, we investigated the modulatory effect of ethnic and cultural context on neural responses to in-group and out-group faces. In order to facilitate ethnic and cultural in-group and out-group categorization, we used ethnic and cultural primes.

In our study, context was given by the presentation of pictures of ethnicity or culture. Ethnic context was primed by using relevant ethnic primes (i.e. Indian faces primed with Taj Mahal or Chinese faces primed with Chinese temple) and the common shared cultural context was primed with images of famous monuments of Singapore (i.e. Marina Bay Sands, Esplanade). Refer to Figure 1 for all ethnic and cultural primes. Visual priming is a consolidated paradigm used extensively in many cognitive tasks from memory (Grill-Spector, 2008) to recognition (James et al., 2000) and it was successfully used to investigate the contextual influence on perceptual mechanisms in face processing (Bentin et al., 2002). The primes were selected such that they symbolically represent the relevant ethnicity or common shared culture, which was previously shown to be successful in a study by Yap et al. (2017), where symbolic representation of culture influence skin conductance during their experimental manipulation. Out-groups and in-groups were investigated in relevance to only one ethnicity in order to control for any ethnicity-related effects. Only Singaporean Chinese participants were investigated.

Aim and Hypothesis

This study looked at how Chinese Singaporeans responded to in-group faces (IF) and out-group faces (OF) in order to i) investigate how common shared culture (CulCon) and ethnic contexts (EthCon) shaped brain responses to in-group and out-group faces in multicultural societies. Neural responses towards typical (Chinese and Indian) and non-typical (Arabic and Caucasian) ethnicities in Singapore were assessed. This allowed distinguishing any neural differences between the typical and non-typical ethnicities as well. Focusing further only on typical ethnicities (Chinese and Indian) in Singapore this study ii) investigated the neural underpinnings of an enlarged cultural in-group that drives an automatic and spontaneous sense of

membership to a multi-ethnic group. Since a common shared culture can be developed with frequent exposure and interaction amongst commonly present ethnic groups, only typical ethnicities were used to investigate the neural underpinnings of an enlarged cultural in-group in order to eliminate any divergence in identifying with a common shared culture. Since this study was conducted in a relatively well-integrated multicultural society, this study was also able to shed light on iii) understanding how individuals' perception and attitudes modulated by positive endorsement and promotion of multi-ethnic integration influenced their cerebral responses.

Based on the review of policies in multicultural society such as Singapore, that was further corroborated by a survey conducted by Mathew et al. (2017), showing that social integrity and cohesion is stronger among the typical ethnicities, it was hypothesized that neural responses to cultural and ethnic contextual manipulation would differ towards non-typical ethnicities and typical ethnicities. For the typical ethnicities, differential recruitment of neural areas towards processing in-group (Chinese) and out-group (Indian) faces in the cultural and ethnical context was expected. Based on the literature review, in-group face processing was expected to recruit brain regions that reflect automatic and implicit processing, such as, the FG, and low-level/early visual cortex regions since these are the regions that have been implicate in in-group face processing. Exposure to different cultures leads to less out-group like neural activations (Derntl et al., 2009; Zuo & Han, 2013). Thus, higher effort in processing out-group faces was expected, instead of typical out-group like neural activation such as the amygdala or insula. This higher effort characterized by neural recruitment of the social cognitive network, such as, the superior temporal sulcus, visual association area, somatosensory cortices, and temporoparietal junctions

was predicted while processing out-group faces in the ethnic context compared to the culture context. This study posits that a common shared culture will drive an automatic and spontaneous sense of membership to a multi-ethnic group. Thus, it was also hypothesized that, if a common shared culture was primed (i.e. the culture context), the OF will be a part of an enlarged cultural in-group and thus there would not be any difference in OF and IF processing in the cultural context.

Relevance

This study is groundbreaking as it is the first to investigate the brain mechanisms of enlarged in-groups. This project presents a significant contribution to the literature on individual and environmental factors that influence the neural responses of affective and cognitive mechanisms underlying the social perception of in-group and out-group membership. Complex integration between affective and cognitive mechanisms and ethnic-cultural factors, which all together drive the final sense of membership of a social group, was covered in this study. In particular, findings from this study would demonstrate how common shared culture or ethnicity would drive an automatic and spontaneous sense of membership towards various ethnic groups. In general, this project initiates towards integrating and building a model of the multicultural social brain.

Chapter IV: Methods

Participants

A total of 48 participants (50% females) aged between 21 to 26 years ($M = 22.81$, $S.D. = 1.17$) took part in this study. All participants were recruited from Nanyang Technological University (NTU), Singapore, by email adverts and word-of-mouth. All participants were Singaporean Chinese who have not travelled out of Singapore for more than two months over the past six months from the time of their experimental session. They were also screened to ensure right-handedness, normal or corrected-to-normal vision, and no history of psychological or neurological disorders. All female participants were not pregnant. Participants had to refrain from alcohol, nicotine, and caffeine consumption 24 hours prior to the scan session. This study was approved by the NTU IRB (Appendix A). Written informed consent (Appendix B) was obtained from all participants.

Experimental Task

To measure the effect of context (CulCon and EthCon) on brain responses to IF and OF in Chinese Singaporean participants, we asked participants to view images of faces primed with CulCon or EthCon during the fMRI scan. Since the participants were all Singaporean Chinese, the IF consisted of Chinese faces. The OF consisted a common typical ethnicity present in Singapore, Indian faces, and non-typical ethnicities of Singapore, Arab and Caucasian faces. CulCon comprised of famous buildings/monuments of Singapore (e.g. Merlion, Esplanade) and EthCon contained famous buildings relevant to each ethnicity (e.g. Taj Mahal for Indian ethnicity, Chinese temple for Chinese ethnicity). These images were selected to symbolically represent either ethnicity or common shared culture. This symbolic representation of culture was successful in a study conducted by Yap et al. (2017). All images were

presented in grayscale. All face stimuli were female and were masked with a grey round window such that only facial features were visible, with no hair or neck made visible. Each trial started with a fixation cross displayed between 7 – 10 seconds, followed by a contextual prime displayed for 2 seconds, then followed by an image of a face (Figure 1). The task consisted of a total of 32 trials with 8 faces of each ethnicity (Chinese, Indian, Arabic, and Caucasian). The faces and their preceding contextual primes were all randomized for each participant. The duration of the fixation cross was also randomly jittered to achieve 8 occurrences of 7, 8, 9, and 10-second fixations. To assess the effect of EthCon, only congruent EthCon to ethnic faces were considered (e.g. Indian faces only preceded by Taj Mahal EC, Caucasian faces only preceded by Eiffel Tower EC). Since this is a passive viewing task, to confirm if all participants were paying attention to the images displayed, at the end of the task a probe on “where was your attention focused on just before the probe” was asked to each participant. The participants had to respond on a Likert scale of 1 (Off-Task) – 10 (On-Task). Participants were asked to answer honestly as there was no right or wrong answer. Only participants whose points were 5 and above were used for the analysis, which encompasses all the 48 participants ($M = 7.19$, $SD = 1.70$).

Figure 1. Task paradigm. The task consisted of a total of 32 trials. Each trial started with a fixation cross displayed between 7 – 10 seconds, followed by a contextual prime displayed for 2 seconds, then an image of a face. All images were presented in random order. Faces of four ethnicities were categorized into typical ethnicities (Chinese and Indian faces) of Singapore and non-typical ethnicities (Arabic and Caucasian faces). Typical ethnicities were further categorized into IF (Chinese faces) and OF (Indian faces). CC comprised of famous buildings/monuments of Singapore (e.g. Merlion, Esplanade) and EC contained famous buildings relevant to each ethnicity (e.g. Taj Mahal for Indian ethnicity, Eiffel Tower for Caucasian ethnicity).

Procedure

All testing took place at the Cognitive Neuroimaging Centre at NTU. Prior to their testing session, eligible participants were briefed on the study. On the day of testing session, they had to undergo MRI safety briefing before they were scanned. Participants were also reminded of the voluntary nature of the study and gave written informed consent. The experimental task took place during the fMRI scan, where the images were displayed on a screen and participants viewed these through a mirror positioned at their eye level on the head coil. Participants were instructed to simply view the images displayed to them during the scan. Anatomical scans were also

obtained. Participants also completed two other experimental tasks while scanning that will not be discussed nor analyzed here. After the scan session, participants were debriefed (Appendix C) about the specific aims of the study and were provided monetary reimbursement of S\$50.

fMRI Data acquisition

Whole brain neuroimages were collected using a Siemens Magnetom Prisma 3-Tesla MRI Scanner with 64-channel head coil. A high-resolution T1-weighted MPRAGE sequence (192 slices; TR 2300ms; TI 900ms; flip angle 8 degrees; voxel size 1mm) was obtained first, which served as an anatomical reference. Subsequently, functional images were obtained using a gradient Echo Planar Imaging (EPI) sequence with 36 axial slices (271 slices; slice thickness 3mm with no inter-slice gap), and the following parameters: TR 2000ms; TE 30ms; flip angle 90 degrees; FOV 192 x 192 mm; voxel size 3mm; interleaved. External head restraint (i.e. neck padding) was used to minimize head movement during the scan.

fMRI Data analysis

fMRI analysis was conducted using Statistical parametric mapping (SPM12; (<http://www.fil.ion.ucl.ac.uk/spm/software/spm12/>) on the Matlab 2017b platform. Discarding the first two volumes of the functional time series, correcting for head movement with first slice as reference, and then co-registering the T1 anatomical image to the mean of the realigned functional images carried out functional image preprocessing. Functional images were then normalized to the Montreal Neurological Institute (MNI) stereotaxic standard space and finally smoothed spatially (9-mm full-width half-maximum Gaussian kernel) and temporally (cut-off period 256 s). Analytic design matrices were constructed for each participant, which modeled the onsets and

duration of the face image from each trial as epochs convolved with a hemodynamic response function.

General linear modeling (GLM) was performed to assess the effect of ethnic and cultural context amongst typical ethnicities in Singapore (Chinese and Indian faces) and non-typical ethnicities in Singapore (Arabic and Caucasian faces). A total of four conditions; typical ethnic faces in CulCon, typical ethnic faces in EthCon, non-typical ethnic faces in CulCon, and non-typical ethnic faces in EthCon were modeled as separate regressors. Specific weight vectors were denoted to derive t-contrast images for group level (2nd Level), mixed-effect analysis. The contrasts of interest were i) *typical faces in CulCon vs. typical faces in EthCon* to investigate the effect of culture and ethnic contexts on typical Singaporean faces; and ii) *non-typical faces in CulCon vs. non-typical faces in EthCon* to assess the effect of cultural and ethnic contexts on non-typical Singaporean faces. In the 2nd level random-effect analysis, one sample t-tests was conducted to assess group effects on the contrast images from the 1st level. The t-tests indicated whether observed differences in the abovementioned contrasts differed significantly from zero (Holmes and Friston, 1998). This will allow for inferences across participants and thus generalizability to the population.

Another GLM was performed to further assess the effect of cultural and ethnic context amongst IF and OF of typical ethnicities in Singaporean. A total of four conditions were modeled as separate regressors; IF in EthCon, OF in EthCon, IF in CulCon, and OF in CulCon. Specific weight vectors were denoted to derive t-contrast images for group level (2nd Level), mixed-effect analysis. The contrasts of interest were i) *IF in CulCon vs. IF in EthCon* to compare neural responses of in-group faces primed with cultural context to in-group faces primed with ethnic context; ii) *OF in*

CulCon vs. OF in EthCon to compare neural responses of out-group faces primed with cultural context to out-group faces primed with the ethic context; iii) *OF in CulCon vs. IF in CulCon* to assess how neural responses to OF and IF differed in the cultural context; and lastly iv) *OF in EthCon vs. IF in EthCon* to assess how neural responses to OF and IF differed when primed with ethnic context.

Threshold significance of $p < 0.05$ was set for all functional imaging data with a cluster-wise ($k = 10$) family-wise error rate (FWE) correction for multiple comparisons (Logan & Rowe, 2004). Whole brain analyses were performed.

Chapter V: Results

Typical and Non-typical ethnicities in Cultural and Ethnic Contexts

To investigate the difference in brain responses towards faces of typical ethnicities present in Singapore (Chinese and Indian) and non-typical ethnicities (Arab and Caucasian) in the cultural and ethnic contexts, contrasts *typical faces in CulCon vs. typical faces in EthCon* and *non-typical faces in CulCon vs. non-typical faces in EthCon* were assessed. Peaks of all brain activations for these respective contrasts are summarized in Table 1.

Higher activations in the right superior temporal sulcus (STS), left middle temporal gyrus (MTG), right supramarginal gyrus (SMG), right visual association area (VAA), left VAA extending to the lingual gyrus (LG), and the right primary sensory area (PSA) comprising of the postcentral gyrus (postCG) were seen when Chinese Singaporean participants viewed faces of typical ethnicities within the cultural context compared to viewing them in the ethnic context. Higher activation of the fusiform gyrus (FG) and middle occipital gyrus (MOG) were obtained when participants viewed faces of typical ethnicities within the ethnic context compared to viewing them in the cultural context. In contrast, the only activation seen for non-typical ethnicities was in the right fusiform gyrus where it showed higher activation in the ethnic context compared to the cultural context. Refer to Figure 2 for difference in activation patterns for faces of typical ethnicities and non-typical ethnicities in ethnic and cultural contexts.

Neural Responses to In-group Faces in Cultural and Ethnic Contexts

To investigate brain responses to in-group Chinese faces in cultural and ethnic contexts, we compared neural responses of in-group faces primed with cultural context to in-group faces primed with ethnic context (*IF in CulCon vs. IF in EthCon*).

Table 2 shows the peaks of all brain activations for the *IF in CulCon vs. IF in EthCon* contrast. While viewing in-group faces in the cultural context, significant activations of the right VAA comprising of the LG, right PSA comprising of the postCG, and rolandic operculum (RO), a part of the secondary somatosensory area (Dorland, 2011) was obtained compared to brain activations while viewing the in-group faces in the ethnic context. In contrast, viewing in-group faces in the ethnic context lead to higher activations in FG and MOG. All activations were limited to the right hemisphere (Figure 3).

Figure 2. A) Brain activations to typical ethnicities in Singapore in cultural versus ethnic context (*typical faces in CulCon > typical faces in EthCon*), shows activation in multiple regions compared to **B)** which shows activation only in the FG for non-typical ethnicities in cultural versus ethnic context (*non-typical faces in CulCon > non-typical faces in EthCon*).

Figure 3. Brain activation of in-group Chinese faces in cultural context versus ethnic context (*IF in CulCon > IF in EthCon*).

Neural Responses to Out-group Faces in Cultural and Ethnical Contexts

Neural responses of culturally primed out-group faces were compared to ethnically primed out-group faces (*OF in CulCon vs. OF in EthCon* contrast) to understand the effect of context on out-group faces. Due to the lack of ample trials, as we have obtained this contrast from a larger task, and with a stringent FWE correction, no significant activation was found at significance level (FWE) <0.05 . However, with a less stringent uncorrected significance level at 0.001 we found higher activation in the VAA, right FG, and the left postCG, a part of the somatosensory cortex (Chan & Baker, 2015; Green et al., 2018). These activations were only found for out-group faces in the ethnic context compared to out-group faces in the cultural context. Table 3 shows the peaks of all brain activations for the *OF in CulCon vs. OF in EthCon* contrast.

Comparing Neural Responses of Out-groups and In-groups in Cultural Context

If common shared culture does drive an automatic and spontaneous sense of membership of a multi-ethnic group, then brain responses to out-group faces primed with culture, representative of an enlarged cultural in-group, should be similar to brain responses to in-group faces. Thus, any differences between out-groups and in-groups in the cultural context were assessed (*OF in CulCon vs. IF in CulCon* contrast). We found no significant differences in brain responses to in-group and out-group faces in the cultural context at a FWE corrected significance level at 0.05 (Figure 4A). Even at a less stringent uncorrected significance level at 0.001, the only difference was a higher activation in the right FG when participants viewed in-group compared to out-group faces (see Table 4).

Comparing Neural Responses of Out-group and In-group in Ethnic Context

The contrast *OF in EthCon vs. IF in EthCon* was examined to compare how out-group and in-group faces were processed in the ethnic context. Unlike in the cultural context, we found greater differences in brain activations for in-group and out-group faces in the ethnic context (Refer to Figure 4B). Higher activation of the right VAA extending to the LG, left LG, right sensory association area (SAA), right cuneus, RO a part of the secondary somatosensory area (Dorland, 2011), left STG, and left SMG were found when out-group faces (as opposed to in-group faces) were viewed in the ethnic context (see Table 5).

Figure 4. **A)** No significant difference in brain activation when viewing out-group faces versus in-group faces in the cultural context (*OF in CulCon > IF in CulCon*) suggesting an enlarged in-group based on cultural identity, which is not present in **B)** when viewing out-group versus in-group faces in the ethnic context (*OF in EthCon > IF in EthCon*).

Chapter VI: General Discussion

This study investigated the effect of a common shared cultural and ethnic context on neural responses of Singaporean Chinese participants to ethnic in-groups faces and out-group faces of typical ethnicities present in Singapore and non-typical ethnicities. The main purpose of this study was to understand the neural underpinnings of in-group and out-group perception in multicultural societies. Here it was postulated that identifying with a common share culture among various racial ethnicities in multicultural societies, an automatic and spontaneous sense of membership to multi-ethnic groups is possible. Thus, creating an enlarged cultural in-group. The neural underpinnings of this enlarged cultural in-group was also investigated in this study.

Culture and Ethnic Contexts only affect Typical Ethnicities

Several important results manifested from this study. First, as expected, typical ethnicities and non-typical ethnicities were processed differently in both ethnic and cultural context. Participants showed more sensitivity to contextual primes for typical ethnicities (Chinese and Indian faces) compared to non-typical ethnicities (Arab and Caucasian faces). In the case of Singapore, this can be linked to the policies in Singapore to enhance social integration and cohesion. Most of the policies in Singapore focused on the CIMO ethnicities in creating social harmony amongst them and building a common cultural identity. These findings were in line with the findings from Mathew et al. (2017) showing that Singaporeans were more welcoming to new citizens who come from the traditional Chinese, Malay, or Indian background than other non-typical ethnicities such as Arabs or Africans. Specifically the contextual manipulation of culture in this study may only be relevant to prime a common shared culture which is bound to exist only amongst well-integrated typical ethnicities. Thus,

rendering the contextual manipulation insensitive for non-typical ethnicities as seen in this study.

Higher Social Cognition in Cultural Context

The difference in neural responses for ethnic and culture context for typical ethnicities was greater compared to non-typical ethnicities. A pattern that emerged in this difference was that higher social cognitive regions were recruited while viewing faces in the cultural context compared to a more automatic and implicit processing of faces when viewed in their respective ethnic contexts. In the ethnic context faces were processed relatively automatically. Activation of the FG was obtained, which is one of the core brain regions for face recognition (Tovée, 1995; Zhen et al., 2013). The FG is implicated in top-down and bottom-up perception of visual input. Bottom-up perception includes higher FG activation to racial in-group faces than out-group faces (Guassi Moreira et al., 2016; Molenberghs, 2013; Shkurko, 2012; Van Bavel et al., 2008).). Top-down modulation of FG in social perception involves indexing socially significant perceptual input according to preexisting schemas of the social environment (Shkurko, 2012). Thus FG is considered the first few regions to respond to social faces. Although the MOG is involved in initial face processing as well (Pizzagalli et al., 2000), it also forms connections to higher social cognition areas such as the STS (Duvernoy & Bourgouin, 1999; Jiang et al., 2018) and specialized cortices involved in emotional and value processing (Olson et al., 2013). Certain connections to higher-level social cognitive areas maybe due to the mixture of in-group Chinese and out-group Indian faces in typical ethnicities.

What is clear from this finding is that in the cultural context, there is evidence for higher-level social cognition regardless of the amalgam of in-group and out-groups in typical ethnicities. Higher activations in regions associated with social

perception and cognition; STS (Freeman et al., 2010; Katsumi & Dolcos, 2018; Schobert et al., 2017), left MTG (Platek, et al., 2006; Quadflieg, 2009), right SMG (Igelström & Graziano, 2017; Schurz et al., 2017; Zheng et al., 2017), right VAA, left VAA extending to the LG (Adolphs, 1999; Colton et al., 2013; Scheepers et al., 2013), along with the mirror neuron system (MNS); PSA comprising of the postCG (Sugranyes et al., 2011; Valchev et al., 2016) were obtained when typical ethnic faces were viewed in the cultural context compared to ethnic context. Thus, in the cultural context, brain regions involved in social cognition, self-perception networks, and theory of mind networks were more active.

This notion is further supported by a similar pattern of neural responses to in-group Chinese faces in the cultural compared to the ethnic context. While viewing in-group faces in the cultural context, significant activations in higher order processing brain regions such as the right VAA comprising of the LG involved in social function (Adolphs, 1999), self-perception (Colton et al., 2013; Freeman et al., 2010; Scheepers et al., 2013), and higher activations in the MNS regions such as the right PSA comprising of the postCG (Sugranyes et al., 2011; Valchev et al., 2016) and RO, a part of the secondary somatosensory area (Dorland, 2011) implicated in perception of social emotions (Han, 2015; Pourtois et al., 2004) and the temporoparietal (TPJ) network (Ionta et al., 2014) was obtained compared to brain activations while viewing the in-group faces in the ethnic context.

Thus, a subset of similar regions that were activated in the cultural context for typical ethnicities, mainly the MNS regions, and brain regions involved in social perception, the VAA comprising of the lingual gyrus (Adolphs, 1999; Colton et al., 2013; Freeman et al., 2010; Scheepers et al., 2013), and the TPJ networks were highly activated for in-group faces in the cultural context. The MNS system is famous for its

activation while observing behavior of other people (Rizzolatti & Craighero, 2004). MNS is implicated in neurocognitive functions such as social cognition, empathy, and theory of mind (Rizzolatti & Craighero, 2004; Sugranyes et al., 2011). TPJ is associated with theory of mind and mentalizing (Freeman et al., 2010; Shkurko, 2012). Theory of mind refers to explaining or predicting other people's behavior by way of reading, reasoning, and representing their independent mental states (Freeman et al., 2010). These regions are involved in self-other distinctions and inferring about people (Greven & Ramsey, 2017; Molenberghs, 2013).

In contrast in-group faces were processed relatively automatically, similar to how faces of typical ethnicities were processed. As expected, viewing the in-group faces in the ethnic context showed typical innate like in-group brain activation compared to viewing them in the cultural context; higher activations FG (Iidaka, 2014; Molenberghs, 2013; Van Bavel et al., 2008) and MOG (Jiang et al., 2018; Olson et al., 2013). These activations were seen only in the right hemisphere that is more active in the interpretation of social information processing (Semrud-Clikeman et al., 2011).

Overall, results indicate that in the cultural context, individuals engage higher social cognitive resources in order to make individuating judgments of people rather than superficial judgments based on group categorization (Freeman et al., 2010).

More Effort in Processing Out-group Faces in Ethnic Context, But No Out-group Activation

Although not evident in a stringent FWE corrected p-value, brain regions linked to enhanced visual processing, mentalizing networks, and social perception were active in out-group face processing in the ethnic context compared to the cultural context. Specifically, higher activation in the VAA implicated in enhanced

visual processing (Rosen et al., 2018), right FG which is sometimes implicated in out-group face processing (Iidaka, 2014; Shkurko, 2012) and the left postCG, a part of the somatosensory cortex (Chan & Baker, 2015; Green et al., 2018) involved in mentalizing networks (Sugranyes et al., 2011), social emotions (Bernhardt & Singer, 2012; Keysers et al., 2010;) and social perception (Schaefer et al., 2013; Valchev et al., 2016) were obtained. This was only seen in the uncorrected p-value analysis. Activation in the FG was also present. FG is commonly associated with in-group face processing (Guassi Moreira et al., 2016; Molenberghs, 2013; Shkurko, 2012; Van Bavel et al., 2008). However, there are studies that have reported FG activations during out-group face processing as well (Ronquillo, 2010; Shkurko, 2010). This may represent the top-down process involved in explicit social categorization in response to the social context (Shkurko, 2010). Overall, as hypothesized, there was higher social and cognitive effort dispensed into processing out-group faces in the ethnic context.

A similar pattern of activation was also seen while comparing neural responses of out-group to in-group faces in the ethnic context. Higher activation of the right VAA, implicated in higher visual processing (Rosen et al., 2018) and social function (Adolphs, 1999; Webb, 2017), LG, associated with out-ward directed social and contextual focus (Colton et al., 2013) and theory of mind networks (Freeman et al., 2010; Scheepers et al., 2013), higher activation in right SAA implicated in social emotions (Han, 2015; Pourtois et al., 2004), and linked to higher order visual processing (Serino et al., 2009), activations in the right cuneus implicated in the social categorization (Platek & Kemp, 2009), RO implicated in perception of social emotions (Han, 2015; Pourtois et al., 2004) and the TPJ network (Ionta et al, 2014), left STG , and left SMG associated with social perception (Bollinger et al., 2010;

Freeman et al., 2010; Igelström & Graziano, 2017; Katsumi & Dolcos, 2018; Schobert et al., 2017) were found when out-group faces (as opposed to in-group faces) were viewed in the ethnic context. Therefore, activations of higher visual processing and social cognitive regions were activated for out-groups in the ethnic context indicated more effort in processing the out-group faces in the ethnic context.

As expected, brain regions characteristic of out-group activation such as the amygdala (Derntl et al., 2009; Freeman et al., 2010; Molenberghs, 2013; Shkurko, 2010; Van Bavel et al., 2008), ACC (Cunningham et al., 2004; Kaplan et al., 2007; Knutson et al., 2007), or insula (Falk et al., 2012; Kaplan et al., 2007; Phelps et al., 2000) were not found in the study. Amygdala is implicated in social categorization and implicit racial bias (Cunningham et al., 2004; Shkurko, 2010). Cunningham et al. (2004) reported amygdala activation when faces were presented before conscious processing (30ms) could occur. Such activation was absent when faces were presented for a longer duration (525ms) allowing for conscious processing where implicit racial bias would be regulated. Therefore a possible reason for the lack of amygdala activation could be because the face stimuli was presented for 4 seconds allowing for any regulation of racial bias. If this stands true for the current study, then ACC activation should have been obtained, to consciously regulate out-group bias, similar to that of Cunningham et al.'s (2004). However no activation in the ACC was found here.

ACC is believed to be involved in self-regulatory functions, such as, monitoring and suppression of negative emotions toward out-group members (Cunningham et al., 2004; Shkurko, 2010). Insula is implicated in avoidance behavior in a social context with uncertainty or danger (Shkurko, 2010). Significant activations in these regions may not be present due to fact that the participants belong to a

multicultural society. Due to frequent social interaction and a well-established social cohesion, there is no perception of uncertainty or danger, nor there is a need to monitor or suppress negative emotions towards out-groups resulting in lack of activation in the insula or ACC, respectively.

In fact exposure to multi-ethnic societies, including out-groups, reduced racial bias. Zuo and Han (2013) reported neural activity in the pain matrix, including the anterior cingulate cortex and anterior insula, did not differ for Asian and Caucasian models when Chinese adults brought up in Western countries were made to see video clips of either Asian or Caucasian models receiving painful stimulations. Derntl et al. (2009) reported a decrease in amygdala activation in Asians who stayed longer in Europe during an explicit emotion recognition task involving Caucasian actors.

Similarly, due to exposure to multi- ethnic societies for the participants in the current study, the out-group bias was already diminished. Thus, in the ethnic context participants automatically used more cognitive and affective resources to perceive the faces of out-group members that weren't characteristic of typical out-group neural responses.

Enlarged In-group Present in Cultural Context

In this study all our participants were Chinese Singaporean citizens who have spent majority of their life in Singapore thus ensuring they have ample exposure to all the ethnicities in Singapore. When neural responses to out-group faces and in-group faces were compared in the cultural context, no significant difference was found. Even with using the less stringent significance level (FWE uncorrected significance level at 0.0001) the only difference was activation in the right FG for in-group faces. In contrast the difference between out-group and in-group faces in ethnic context was much greater. A higher social, cognitive, and affective processing

was found for out-group faces in the ethnic context, as discussed earlier. As expected the lack of difference in neural responses to out-group and in-group faces indicates that out-groups are processed similarly to in-groups. This phenomenon is characteristic of an enlarged cultural in-group. These findings are similar to pattern of findings by Zuo and Han (2013) who found no difference in neural activity in the pain matrix for in-group (Asians) and out-groups (Caucasians) amongst Chinese adults brought up in Western countries.

Sheng and Han (2012) proposed racial bias in empathy occurs when out-group faces are perceived as a social group rather than an individual person. The authors postulated that manipulation of cognitive strategies and intergroup relationships would enhance the individuating processing and thus increase empathetic neural responses to other race faces. Borrowing from this notion, well-integrated multicultural societies like Singapore already have enhanced intergroup relationships. Furthermore, the contextual priming of either ethnicity or a common shared culture lead to the employment of different cognitive strategies towards perceiving in-group and out-group faces. Specifically, cultural priming enhanced individuating processing of out-groups and ethnic in-groups. Findings from this study show that in a well-integrated multicultural society, identifying with a common shared culture does drive an automatic and spontaneous sense of membership to a multi-ethnic group, thus establishing an enlarged cultural in-group.

Implications

Findings from this study demonstrated that identifying with a common shared culture, more than ethnicity, can drive an automatic and spontaneous sense of membership to a multi-ethnic group when the society explicitly and positively supports cross-ethnic interactions in every daily life context. Moreover, increasing

the willingness of people to be in social contact with others regardless of ethnicity encourages the development of common communication skills; with shared verbal and non-verbal channels underlying emotional communication, therefore improving understanding of others (Soto & Levenson, 2009). These findings demonstrate that living in proximity and with inclusive attitude with citizens from other ethnicities can expand the sense of membership of individuals to a member of a cultural group. The results shed light on a possible emergent phenomenon in Singapore, the development of a new way to categorize oneself and others, in terms of membership, which stands between the classical ethnic in- and out-group categorization and where culture and not ethnicity shapes and drives spontaneous social judgment of others (Figure 5). Additionally the policies of enforced intergroup interaction are producing important effects that are reflected at a neural level that goes beyond the mere exposure effect. These findings can be extended towards similar well-integrated multicultural societies other than Singapore.

Figure 5. Graphical representation of a likely scenario of in- and out-group membership dynamics in Singapore. Red and yellow colors are namely ethnic-based in-groups and out-groups; orange color is the new phenomenon of the culture-based enlarged in-group which integrates features from both of the above mentioned groups.

Limitations

Although results from this study have applicable implications, it does not come without limitations in term of generalization. One such limitation is that only the majority ethnicity of Singapore; Chinese participants were used in study. This was done to control for any ethnicity related difference in face processing and due to

convenience sampling – it was easy to get many participants from a majority racial group. However majority and minority groups may perceive and experience intergroup relations differently in accordance to their experiences (Dovidio et. al, 2008). In order to get a holistic understanding, neural responses to ethnic in-group, enlarged cultural in-groups, and out-groups should be investigated amongst minority groups as well.

Another such limitation of the study is the sample of the age group. All participants were mostly current students of NTU or who recently graduated. Age differences were reported in studies involving in-group and out-group (Guassi Moreira et al., 2016) and social cognition areas (Colten et al., 2013). Therefore the effect of enlarged cultural in-group and the effect of cultural and ethnic contexts is necessary to be investigated across generations or age groups using a cross-sectional study in order to be able to wholly generalize the findings.

Posing another limitation is that the face stimuli used in this study is only of female gender. Research from intergroup relations has shown that gender influences in-group racial bias. Different psychological systems for men and women underlie intergroup bias (e.g. Navarrete et al., 2010; Rudman & Goodwin, 2004). Although this wasn't the aim of the study, in order to provide a complete framework of in-group and out-group face processing in multicultural societies, face stimuli should be both male and female in order to analyze any gender effects.

Lastly, all the faces were unfamiliar to participants. Familiar and new faces have differing neural activation. Reduced activation in amygdala and fusiform gyrus is observed during the presentation of familiar faces (Gobbini & Haxby, 2006). Familiarity causes changes in neural response that extend beyond the visual memory for the face (Gobbini et. al, 2004). Moreover, intergroup friendships are common in

multicultural societies. Therefore, it is necessary to understand the neural representation of familiar faces in ethnic in-group, culturally enlarged in-group, and out-group faces.

All these limitations set stage for further research in order to build a better understanding of the complex integration between affective, cognitive, and ethnic-cultural factors which drive the sense of membership towards in-groups or out-groups. This study can also be extended to investigating brain reactivity and responsiveness to different ethnic baby faces in a multicultural society and the effect of the environmental context. This initial step into understanding this complex interaction calls for an integrated perspective that can connect and explain findings acquired from multi-level approaches (fMRI, physiological, and behavioral data). There is a need for studies to examine the global profile of a specific response to social stimuli in multicultural countries: multiple perspectives would help to trace a direct link between the brain and physiological responses to behaviors and attitudes. Such insight will give a strong theoretical contribution to building an integrated and general model of the social brain.

Conclusion

Although findings from this study come with certain limitations, it is the first step towards integrating and constructing a model of the multicultural social brain. Building and identifying with a common shared culture in multicultural societies enhances individuating processing of ethnic out-groups, and leads to formation of an enlarged cultural multi-ethnic in-group. In a well-integrated multicultural society, members do not innately respond to other ethnicities with typical out-group bias responses but dispense more social and cognitive resources into perceiving them more as individuals than superficially as an out-group. These pioneering findings about

existence of a enlarged cultural in-group opens opportunity for future research in order to develop on the understanding of multicultural societies and its complex interaction with contextual environment towards dynamic perceptions of in-groups and out-groups through a multi-level approach.

Table 1.

Sites of significant neural activation ($p < 0.05$, FWE correction) related to the contrasts *typical faces in CulCon vs. typical faces in EthCon* and *non-typical faces in CulCon vs. non-typical faces in EthCon*.

Comparison of Interest			Brain Regions	BA	Left/Right	MNI Coordinates			Voxels at $p(\text{FWE}) < .05$	MeanT
						x	y	z		
typical faces in CulCon	>	typical faces in EthCon	Superior Temporal Gyrus	22	Right	60	-7	8	53	5.3192
			Supramarginal gyrus	40	Right	48	-31	20	17	5.3207
			Visual Association Area	18	Right	12	-94	20	34	5.2318
			Visual Association Area/Lingual gyrus	18	Left	-9	-70	-4	12	5.6930
			Middle Temporal gyrus	21	Left	-63	-37	8	24	5.1921
			Primary Sensory Area/Postcentral gyrus	1	Right	27	-40	62	24	5.1568
typical faces in EthCon	>	typical faces in CulCon	Fusiform gyrus	37	Right	30	-46	-13	104	6.4733
			Middle Occipital gyrus	19	Right	33	-76	20	70	6.1197
			Fusiform area	37	Left	-33	-49	-13	59	5.9118
			Inferior frontal gyrus	44	Right	42	8	32	30	5.6794
			Middle Occipital gyrus	19	Left	-27	-85	17	71	5.6935
non-typical faces in CulCon	>	non-typical faces in EthCon	-							
non-typical faces in EthCon	>	non-typical faces in CulCon	Inferior fusiform gyrus		Right	33	-49	-7	39	5.4603

Table 2.

Sites of significant neural activation ($p < 0.05$, FWE correction) related to the *IF in CulCon vs. IF in EthCon*.

Comparison of Interest			Brain Regions	BA	Left/Right	MNI Coordinates			Voxels at $p(\text{FWE}) < .05$	MeanT
						x	y	z		
IF in CulCon	>	IF in EthCon	Primary Sensory area/Postcentral gyrus	1	Right	33	-22	44	160	5.3023
			Rolandic Operculum		Right	51	-16	11	102	5.3401
			Visual association area/Lingual gyrus	18	Right	9	-70	-1	11	5.3043
			Cuneous		Right	12	-82	26	37	5.3215
IF in EthCon	>	IF in CulCon	Inferior fusiform gyrus		Right	33	-52	-10	25	5.7091
			Posterior fusiform gyrus		Right	30	-70	-7	17	5.5064
			Middle occipital gyrus		Right	33	-76	20	13	5.4532

Table 3.

Sites of significant neural activation ($p < 0.001$, uncorrected) related to the contrast *OF in CulCon vs. OF in EthCon*.

Comparison of Interest			Brain Regions	BA	Left/Right	MNI Coordinates			Voxels at p(uncorr)<.0001	MeanT
						x	y	z		
OF in CulCon	>	OF in EthCon				No voxles survied threshold				
OF in EthCon	>	OF in CulCon	Fusiform		Right	33	-46	-7	107	3.9091
			Lingual		Left	-24	-64	-7	74	3.7296
			Visual association area	18	Right	15	-73	-1	23	3.5755
			Postcentral gyrus		Left	-39	-19	26	18	3.4173

Table 4.
Sites of significant neural activation related to the contrast *OF in CulCon vs. IF in CulCon*.

Comparison of Interest			Brain Regions	BA	Left/Right	MNI Coordinates			Voxels	MeanT
						x	y	z		
<i>p(FWE) < 0.05</i>										
IF in CulCon	>	OF in CulCon	-							
OF in CulCon	>	IF in CulCon	-							
<i>p(uncorr) < 0.0001</i>										
IF in CulCon	>	OF in CulCon	Fusiform gyrus		Right	33	-46	-7	42	4.5133
OF in CulCon	>	IF in CulCon	-							

Table 5.
Sites of significant neural activation ($p < 0.05$, FWE) related to the contrast *OF in EthCon vs. IF in EthCon*.

Comparison of Interest			Brain Regions	BA	Left/Right	MNI Coordinates			Voxels at $p(FWE) < .05$	MeanT
						x	y	z		
IF in EthCon	>	OF in EthCon	Fusiform area		Right	33	-52	-10	35	5.4098
OF in EthCon	>	IF in EthCon	Visual association area/Lingual gyrus	18	Right	9	-70	-1	32	5.4935
			Lingual gyrus		Left	-9	-64	-7	27	5.5316
			Sensory Association area	5	Right	21	-43	62	98	5.2934
			Rolandic Operculum		Right	51	-31	20	89	5.2849
			Cuneus		Right	12	-82	29	34	5.3759
			Rolandic Operculum		Left	-39	-19	23	10	5.2938
			Rolandic Operculum	6	Right	54	-4	5	21	5.2983
			Superior Temporal gyrus		Left	-57	-25	11	18	5.2113
			Supramarginal gyrus	40	Left	-60	-34	29	12	5.1392

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Appendices

Appendix A: IRB Approval

Research Integrity and Ethics Office

Reg. No. 200604393R

IRB-2017-01-029

25 August 2017

Assistant Professor Gianluca Esposito
School of Humanities and Social Sciences

NTU INSTITUTIONAL REVIEW BOARD APPROVAL

Project Title: The brain mechanisms behind multiculturalism in Singapore: a neuroscience approach to study in-group and out-group dynamics
(Amount Approved: SGD\$99,360; to be funded by AcRF Tier 1 program)

I refer to your application for ethics approval with respect to the above project.

The Board has considered your application and noted from your application that your research involves collecting behavioral data from participants undergoing fMRI.

You have also confirmed that informed consent will be obtained from the participants and you have guaranteed the confidentiality of your participants' biodata obtained from them.

The documents reviewed are:

- a) NTU IRB application form dated **25 May 2017**
- b) Participant information sheet and consent form: version 1 dated **25 May 2017**
- c) Data collection form: version 1 dated **25 May 2017**

The Board is therefore satisfied with the bioethical consideration for the project and approves the ethics application under **Full Board** review. The approval period is from **25 May 2017 to 02 March 2020**. The NTU IRB reference number for this study is **IRB-2017-01-029**. Please use this reference number for all future correspondence.

The following protocol and compliances are to be observed upon NTU IRB approval

1. All research involving procedures greater than minimal risk on minors (individuals who are less than the legal age of 21 years old) requires IRB approved written Parental Consent and assent from the participant to be obtained before any research protocols can be administered. Minimal risk refers to an anticipated level of harm and discomfort that is no greater than that ordinarily encountered in daily life, or during the performance of routine educational, physical, or psychological examination.
2. Only the approved Participants Information Sheet and Consent Form should be used. It must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject should be given a copy of the signed consent form.

50 Nanyang Avenue, North Spine, NS4-05-92A, Singapore 639798
Tel: (65) 6592-2495
www.ntu.edu.sg

Research Integrity and Ethics Office

3. Consent forms are important documents therefore they should be stored in the strictest arrangement. Loss of consent form would result in disciplinary action.
4. No deviation from, or changes of, the protocol should be initiated without prior written NTU IRB approval of an appropriate amendment.
5. The Principal Investigator should report promptly to NTU IRB regarding:
 - a. Deviation from, or changes to the protocol.
 - b. Changes increasing the risk to the subjects and/or affecting significantly the conduct of the trial
 - c. All serious adverse events (SAEs) which are both serious and unexpected.
 - d. New information that may affect adversely the safety of the subjects of the conduct of the trial.
 - e. Completion of the study.
6. Continuing Review Request/ Notice of Study completion form should be submitted to NTU IRB for the following:
 - a. Annual review: Status of the study should be reported to the NTU IRB at least annually using the Continuing Review Request/ Notice of Study completion form.
 - b. Study completion or termination: Continuing Review Request/ Notice of Study completion form is to be submitted within 4 to 6 weeks of study completion or termination.
7. All Principal Investigators should comply with existing legislation that would have an impact on the domain of their research.

A handwritten signature in black ink, appearing to read 'Lionel'.

Professor Lionel Lee
Chair, NTU Institutional Review Board
encl.

Appendix B: Participation Information Sheet and Consent Form

Social & Affective Neuroscience Lab
Nanyang Technological University, Singapore

INFORMED CONSENT FORM Neurophysiological Mechanisms Behind Multiculturalism in Singapore

1. Participant Criteria

You are invited to participate in this research study as you are a healthy Chinese adult between 21-40 years old, who is currently residing in Singapore. Additionally, you have no history of neurological or psychiatric disorders (any disease related to neurology, brain etc., mental or physiological); you have normal/corrected-to-normal vision; you have no metal in your body (i.e. pacemakers, dental braces), you have no history of claustrophobia (fear of going into confined places) (**Please see Appendix B for a detailed list which enumerates contraindications for MRI studies**) and you are not pregnant (Please see points 5, 6 and 8). Your participation in this study is entirely voluntary. At any point during the study, you are free to withdraw your consent, including your authorization regarding the use and disclosure of your health information, and to discontinue participation at any time, without prejudice to you (Please see point 10).

2. What procedures will be followed in this study

If you decide to participate, you will be asked to undergo two main phases:

Phase I: Online survey session regarding multiculturalism (approximately 50 min)

Phase II: Magnetic resonance imaging (MRI) of your brain (approximately 60 min), but the whole visit at the Cognitive Neuroimaging Centre (CoNiC) NTU will take 90 minutes.

Where: Participants will be asked to complete Phase I at home prior to Phase II. Phase II will be held at Cognitive Neuroimaging Centre (CoNiC), Lee Kong Chian School of Medicine (LKC), NTU.

If you agree to take part in this study, the following events will occur:

Phase I: Online Survey Session

Prior to commencing the neuroimaging and physiological components of the study, you will be required to complete a 50-minute long online survey session. A total of nine questionnaires will be administered to you, assessing your perception and attitudes towards multiculturalism, as well as your personality and individual characteristics. An email with a link to the survey will be sent directly to the email address that you have provided.

This information will help us understand and interpret how certain characteristics are related to the fMRI and physiological data collected. The results from this questionnaire remain confidential, solely for the purpose of academic research.

Phase II: Magnetic Resonance Imaging (MRI)

The whole visit at the Cognitive Neuroimaging Centre (CoNiC), NTU includes the following steps: (1) welcome, ask for the informed consent to use sensitive data, screening for MRI

compatibility and participant preparation for the testing session (10 min), (2) description of the experimental tasks and assisting the participant to assume the correct position inside the scanner, and testing of all the equipment (button box response, earphone to reduce the noise, squeeze ball (10 min), (3) testing session (60-65 min.), (4) post session debriefing (less than 3 min). The total time of the visit will be around 90 minutes.

Firstly, you will be asked to answer a safety check to assess your suitability with MRI scan. You will be briefed about the safety aspects of the MRI. You will be given a set of forms to fill in and the radiographer will evaluate your responses in the forms. If the radiographer finds that you have any medical condition or implants which will affect you during the study, you will not be participating in the study. If you are found to be a suitable subject and are qualified by the radiographer to proceed with the study, you will be asked to change out of your clothes into scrubs, which are provided by the radiographer. After changing in the dedicated changing room, the radiographer will screen you using a metal detector. Then, you will proceed to the scanner and the radiographer will help you to lie down on the scanner bed. You will be given a set of earplugs (disposable) to prevent the noise which will otherwise cause irritation to your ears. The radiographer will check whether your earplugs are properly fitted and will provide a blanket as the room may be cold due to air-conditioning. After preparation, the door will be closed and scanning will start. During the scanning session, the radiographer will interact with you over the two-way speaker. There will be a rubber bulb provided in your hand during the preparation. If you have any problem or not feeling well, you may press the bulb and the alarm will be raised. The radiographer and physician will stop the scan immediately and open the door to bring you out.

All participants will undergo three fMRI sequences (three different tasks) and structural sequences. The first fMRI sequence (Task1) consists of presentation of baby and adult human faces of varying ethnicity. The next fMRI sequence (Task2) will introduce visual contextual stimuli with the human faces, and the last fMRI sequence (Task3) involves visual presentation of objects of common use. The total duration of the MRI scan is around one hour 30 minutes.

MRI is non-invasive and there is no potential risk involved. The scans for the protocol validation will be conducted for structural fMRI (Tasks: #1, #2 and #3).

3. Your Responsibilities in This Study

Before giving your consent to be involved in this study, you should have read the description of the experiments that have been outlined in this sheet. If you agree to participate in this study, you should follow the advice given to you by the research team.

4. Research Purpose of the Study

There is a need for studies to examine the global profile of a specific response to social stimuli in multicultural countries: multiple perspectives would help to trace a direct link between the brain and physiological responses to behaviors and attitudes. Such insight will

give a strong theoretical contribution to building an integrated and general model of the social brain.

Although brain MRI scans may be part of standard medical care, in this study, these procedures are conducted for research purposes alone. Therefore, data obtained from these neurophysiological parameters, during the course of this study, cannot be used for clinical diagnosis or other medical-related purposes.

5. Possible Risks (Phase I, Phase II)

There is no anticipated risk to human subjects participating in this study. However the following measures are taken to ensure that participation in the study will not cause extreme distress in the participant.

In **Phase I**, the online survey will include questions that may be racially/ethnically sensitive, which may be uncomfortable to answer. You will be reminded that they are free to withdraw from the experiment at any moment.

Phase II of the study involves an fMRI scan. Any metal implants, tattoos or metals will cause danger. After changing into scrubs in the dedicated changing room, the radiographer will screen each subject using a metal detector to make sure that there is no metal in your body. You will also fill up an evaluation form (risk assessment) and the radiographer will evaluate the form before commencing with the scan. MRI is non-invasive and there is no potential risk involved in MRI should you be found to be a suitable subject for the study. However, if there is any medical emergency, we will contact medical personnel for advice. Additionally, participants are at risk of high distress if they suffer from claustrophobia (the fear of being enclosed in a small space or room and having no escape). **Appendix B contains a detailed list of contraindications for MRI examinations. Individuals with such contraindications will not receive an MRI scan.**

The fMRI scan is for research purposes only. Every attempt will be made to ensure that your comfort is maintained during the MRI protocol. You will not be pressured to do anything against your will, and you will be allowed to take breaks or seek information at any time. You will be closely observed at all times by the MRI radiographer with whom you can speak throughout the procedure and who will remove you from the scanner at your request. In the event that you experience any distress or have concerns about any parts of the study, research assistants will be trained to raise such concerns during the procedure to the principal investigator.

We would like to ensure you that you may withdraw your participation without any penalty, at any point during the study.

6. Management of Incidental Clinical Findings

In the event where the radiographer observes abnormalities or incidental findings from the MRI data collected, we will refer the image assessed by the Allied Health Professions

Council (AHPC) registered radiographer Principle Investigator. You will be informed and recommended to seek appropriate clinical care. As the data collected from the MRI scan were obtained using an experimental design and not for clinical evaluation, you will have to undergo a formal medical checkup as recommended by your personal physician. We will not be able to provide the images from the MRI scan, or data from the physiological assessment, as a replacement of the clinical checkup. Should such incidental findings occur, the Principle Investigator will assist you in directing you to the relevant medical team. Any financial assistance or medical costs will not be borne by this study.

7. Possible Benefits from Participating in the Study

There is no direct benefit to you in participating in this study. However, knowledge gained as a result of your participation will elucidate the topic of brain response to in-group and out-group social stimuli from a multi-level system perspective. This project will cover the complex integration between affective and cognitive mechanisms and ethnic-cultural factors which all together drive the final sense of belongingness as a member of a social group.

8. Important Information for Female Participants

The effect of MRI on a baby's development is not known. Therefore, pregnant and breast-feeding women may not take part in this study. Women who have a chance of becoming pregnant must have a negative pregnancy test at the entry of the study and use birth control during the study.

9. Reimbursement for Participating in the Study

For your time spent on participating in this study, a total compensation of \$50 will be reimbursed to you, in cash, upon the completion of the study. There will be no pro-rating of payment should you withdraw before the completion of the study.

10. Voluntary Participation and Withdrawal

Your participation in this study is completely voluntary. Should you decide not to continue participating, at any point in time, you may withdraw by informing the Principal Investigator (Gianluca Esposito) or the Research Investigator and/or radiologist in PHASE I and PHASE II. Your decision to participate or withdraw from the study will have no bearings on your status in NTU.

The Investigator and/or the radiologist of this study may stop your participation in the study at any time if they decide that it is in your best interests. They may also do this if you do not follow instructions required to complete the study adequately.

You are free to withdraw from the experiment at any time without providing any reasons, by informing the Principal Investigator or the Research Investigators.

11. Compensation for Injury

If you follow the instructions given by the investigators conducting this study and are physically injured due to the procedure involved, NTU will pay the medical expenses for the treatment of that injury. In the event where injuries are due to noncompliance, or otherwise unrelated to the experimental procedure, medical expenses will not be covered. By signing this consent form, you will not waive your legal rights or release the parties involved in this study from liability for negligence.

12. Confidentiality of Study and Personal Records

Information collected for this study will be kept confidential. Your records, to the extent of the applicable laws and regulations, will not be made publicly available. By signing the Informed Consent Form attached, you are authorizing (i) collection, access to, use and storage of your "Personal Data", and (ii) disclosure to authorised researchers (Head of the laboratory and the research fellow in-charge).

"Personal Data" refers to data about you which makes you identifiable (i) from such data or (ii) from that data and other information which an organization has or likely to have access to.

Any data that may be published in scientific journals will not reveal the identity of the subjects. Any personal information that you have given will be coded such that your anonymity will be maintained.

In order to protect participants' confidentiality, each participant's data will be re-coded with a numeric code replacing identifiers. Only the Principal Investigator (PI), the Co-PI and Research Investigators involved have access to your identifying information with the aim to correctly label and store the collected data. All personal data and collected data (Psychological, MRI and physiological data) in this research project will be securely stored in password-protected laptops and locked in cabinets at the HSS Psychology Department, NTU (accessible only to the PI and Co-PI). MRI data will be securely stored in PACS and NTU server with password (access restricted; accessible only to the Director and Head of Operations at Cognitive Neuroimaging Centre). Backup of data in External Hard Drive with password (access restricted) and locked in cabinets at the HSS Psychology Department, NTU (ONLY PI AND CO-PI'S CAN ACCESS).

If you do not consent to keep your personal data for future research, all identifiers will be erased at the end of this study. Research arising in the future, based on this "Personal Data", will be subject to your consent and the review by the relevant Institutional Review Board (IRB).

13. Who to Contact if You Have Questions

If you have questions about this research study, you may contact:

Principal Investigator
Asst. Prof. Gianluca Esposito
Tel: +65 6316-8836
Email: gianluca.esposito@ntu.edu.sg

Research Fellow
Paola Rigo
Tel: +65 6592-1574
Email: prigo@ntu.edu.sg

If you want an independent opinion to discuss problems and questions, obtain information and offer inputs on your rights as a research subject, you may contact:

Institutional Review Board (IRB) - NTU
Tel: +65 65922495
Email: irb@ntu.edu.sg

If you have any complaints or feedback about this research study, you may contact the Principal Investigator or the Institutional Review Board.

Study Sponsor:
This study is supported by Academic Research Fund (AcRF) Tier 1 Grant 2016 for research projects.

**CONSENT AGREEMENT FORM
PHASE I
(ONLINE SURVEY)**

I give my consent for myself to participate in the PHASE I (online survey) of this research study.

I have fully discussed and understood the purpose and procedures of this study. This study has been explained to me in a language that I understand. I have been given enough time to ask any questions that I have about the study, and all my questions have been answered to my satisfaction.

I understand that participation is voluntary and that I may ask that the session be interrupted or terminated at any time.

Name of Participant

Signature

Date

Consent for the Use of Data for Future Research

I agree / do not agree that my personal data are kept in a subject file for future research-related purposes, and the fact that I have participated in Dr. Esposito's study will be noted. I understand that future research using the data collected will be related to this research area and will be subjected to (1) ask my consent agreement, and (2) the approval of an Institutional Review Board.

- ☐ Yes, I agree to donate my data for future research as long as my consent agreement, and the approval of an Institutional Review Board will be obtained
- ☐ No, I do not agree to donate my data for future research.

Name of Participant

Signature

Date

Investigator Statement

I, the undersigned, certify to the best of my knowledge that the participant signing this informed consent form had the study fully explained in a language understood by him / her and clearly understands the nature, risks and benefits of his / her participation in the study.

Name of Investigator/
Person administering consent

Signature

Date

**CONSENT AGREEMENT FORM
PHASE II
(MAGNETIC RESONANCE IMAGING)**

I give my consent for myself to participate in the PHASE II (MRI scanning session) of this research study.

I have fully discussed and understood the purpose and procedures of this study. This study has been explained to me in a language that I understand. I have been given enough time to ask any questions that I have about the study, and all my questions have been answered to my satisfaction.

I understand that participation is voluntary and that I may ask that the session be interrupted or terminated at any time.

_____	_____	_____
Name of Participant	Signature	Date

Consent for the Use of Data for Future Research

I agree / do not agree that my personal image/data are kept in a subject file for future research-related purposes, and the fact that I have participated in Dr. Esposito's study will be noted. I understand that future research using the data collected will be related to this research area and will be subjected to (1) ask my consent agreement, and (2) the approval of an Institutional Review Board.

- ☐ Yes, I agree to donate my image/data for future research as long as my consent agreement, and the approval of an Institutional Review Board will be obtained
- ☐ No, I do not agree to donate my data for future research.

_____	_____	_____
Name of Participant	Signature	Date

Findings of Clinical Relevance

I understand that in the case of any findings of clinical relevance during the course of the fMRI study, the Allied Health Professions Council (AHPC) registered radiographer will communicate the findings to the Principle Investigator. The Principle Investigator will communicate any such relevant clinical findings to me. I understand that I will be responsible to consult the relevant medical professional thereafter.

_____	_____	_____
Name of Participant	Signature	Date

Investigator Statement

I, the undersigned, certify to the best of my knowledge that the participant signing this informed consent form had the study fully explained in a language understood by him / her and clearly understands the nature, risks and benefits of his / her participation in the study.

Name of Investigator/
Person administering consent

Signature

Date

Appendix B
RISK TYPES THAT WILL BE CHECKED
TO ASSESS YOUR ELIGIBILITY TO THE MRI STUDY

Suffering from claustrophobia

Being pregnant

Possessing metal inside the body:

- Splinters or metal fragments
- Clips on aneurysms (blood vessels), aorta, brain
- Heart valve
- Distractors spine
- Infusion pump for insulin or other medications
- Pace heart-maker or other types of cardiac catheters
- Metallic bodies in the ears or hearing systems
- Neurostimulators, electrodes implanted in the brain or subdural
- Intrauterine bodies
- Spinal or ventricular shunt
- Metal stents (for previous fractures, joint corrective measures, etc.): Screws, nails, wire, and so on

Suffering from sickle cell anemia

Using medicinal products in transdermal patches

Having been involved in accidents/events with high risk of injuries from metal shards. Please see the list below for some examples:

- Having ever worked / works as a welder, turner, coachbuilder?
- Having you ever had traffic accidents, hunting accidents?
- Having you been the victim of trauma from explosions?
- You have undergone surgery on / head / neck / chest / abdomen / end / other

To carry out the examination, the following must be removed:

- hearing aids, dentures, temporary crowns, furniture, sanitary walls
- cosmetics from the face and / or body, clips, barrettes, eyewear, jewelry, cell phones, limes
- watches, credit cards, magnetic cards, pocket knives, scissors, staples

Appendix C: Debrief Form

Social & Affective Neuroscience Lab
Nanyang Technological University, Singapore

DEBRIEF FORM

Neurophysiological Mechanisms Behind Multiculturalism in Singapore

Purpose of the Research Study

This project aims to integrate biological and behavioral findings of affective and cognitive mechanisms underlying the social perception of in-group/out-group membership. In particular, findings from this project will demonstrate that culture more than ethnicity can drive an automatic and spontaneous sense of belonging to a multi-ethnic group when the society explicitly and positively supports cross-ethnic interactions in every daily life context. Findings from this project will shed light on a possible emergent phenomenon in Singapore: the development of a new way to categorize yourself and others, in terms of membership, which stands between the classical ethnic in- and out-group categorization and where the culture and not ethnicity shapes and drives spontaneous social judgment of others.

Who to Contact if You Have Questions

If you have questions about this research study, you may contact:

Principal Investigator

Asst. Prof. Gianluca Esposito

Tel: +65 6316-8836

Email: gianluca.esposito@ntu.edu.sg

Research Fellow

Paola Rigo

Tel: +65 6592-1574

Email: prigo@ntu.edu.sg

If you want an independent opinion to discuss problems and questions, obtain information and offer inputs on your rights as a research subject, you may contact:

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If you have any complaints or feedback about this research study, you may contact the Principal Investigator or the Institutional Review Board.

Study Sponsor

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Thank you, our participants, for supporting our research.