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ROLE OF TEMPOROPARIETAL JUNCTION IN SELF-PERCEPTION

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ABSTRACT

The ability to discern between representations of oneself and those of other people, as well as the ability to move between these representations, is a fundamental component of social cognition. Citation needed for example, if you are trying to see things from the perspective of another person, you have to switch back and forth between representing yourself as "self" and representing yourself as "other" in order to minimize the representation of your own perspective and maximize the representation of the other person's perspective. This is necessary in order to achieve the goal of seeing things from the perspective of the other person. In a similar vein, in order for a person to finish activities involving theory of mind, they must not represent their own beliefs, objectives, or intentions, but rather the beliefs, desires, and aims of another individual. When trying to empathise with another person, it is important to make a distinction between one's own affective state and the affective state that results from one's representation of the emotions of the other person. This is because one's own emotions can be influenced by one's interpretation of the other person's feelings (Singer and Lamm 2009). Again, this calls on the ability to move between representations of one's own emotions and those of other people.

Keyword: social cognition, interpretation, person's perspective.

INTRODUCTION

A person needs to be able to switch between motor representations that are activated by the observation of the actions of another person and motor representations that they have self-generated in order to control imitation, which is an essential component of social interaction (Chartrand and Bargh 1999).

Finally, in order to control imitation, which is an essential component of social interaction, a person needs to be able to switch between motor representations that they have self-generated and motor representations that are activated (Brass et al. 2009). There is some evidence to suggest that a single lower-level mechanism may contribute to all of these tasks, despite the fact that these activities involve a variety of distinct higher-level social cognitive processes. This is despite the fact that these activities require participants to engage in a variety of different social cognitive activities (Decety and Lamm 2007). This lower-level function may be the ability to manage representations of both the self and the other, or more specifically to transition between different versions of both. These representations may take the form of visual views, mental states, emotional states, or behavioural patterns, and they may be subject to control. Within the framework of this concept, the requirement for self- and other-representation control manifests itself whenever the participant is required to stimulate one representation while concurrently suppressing the other representation for the purpose of completing the task. In this piece, we refer to the process of "switching between" the two representations as "switching between" the self-representation and the other-representation. This is because the process involves stimulation of the self-representation and inhibition of the other-representation. This is due to the fact that we refer to the two different representations by using the phrase "switching between." When it comes to exercises dealing with theory of mind, the two representations that are being referred to are those of the mental states of both the self and the other. For instance, in the moral judgement task that was carried out by Young et al. (2010a), the participants were asked to decide whether or not a certain situation was ethically acceptable. This was done in order to determine the effects of the task on the participants. Grace is under the impression that the powder is dangerous despite the fact that I am aware that it does include sugar. It is necessary for me to suppress the depiction of my own mental state and to increase Grace's mental state in order for me to be able

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to finish the assignment. In this specific instance, the project requires me to evaluate Grace's morality in the situation where she uses sugar that has been labelled as "hazardous" in her friend's coffee. Both of these representations are considered to be motor representations when discussing the control of imitation (see, for example, Brass et al. 2001).

For example, as a consequence of the job instructions, I expect to lift my index finger, so activating the motor representation for index finger lifting. On the other hand, the sight of someone else lifting their middle finger triggers the motor representation for middle finger lifting. In order for me to successfully perform the task, I will have to inhibit the motor representation of the other person's behaviour while at the same time enhancing the motor representation that I have independently formed. Therefore, it is arguable that the ability to switch between representations of'self' and 'other,' whether these are mental representations in the case of theory of mind, motor representations in the case of imitation, or representations of visual perspective or emotions, helps to facilitate successful social cognition. This is because theory of mind deals with mental representations, while imitation deals with motor representations. This is because the capacity to grasp the mental states of other people is referred to as theory of mind, and the ability to imitate the acts of other people is referred to as imitation. Researchers have looked for overlapping neural correlates of a variety of social cognitive processes in order to investigate the neurological basis of a person's ability to switch between different representations of themselves and other people. In particular, research has been done in an effort to uncover neural correlates that are shared by the following: A number of meta-analyses have shown evidence that the right temporoparietal junction (rTPJ) plays a role in perspective-taking, theory of mind, and empathy (Decety and Lamm 2007; Decety and Sommerville 2003; van Overwalle 2009). In addition, Brass and his colleagues have contributed a significant amount to the body of knowledge on the subject of imitation control through their extensive study (Brass et al. 2005, 2009; Spengler et al. 2009). The researchers detected an increased reactivity in the region of the brain known as the right temporo-parietal junction (rTPJ), as well as in the medial prefrontal cortex, when individuals were asked to control their tendency to replicate the actions of others (mPFC). Because the vast majority of the evidence that was summarised earlier originated from correlational studies of brain imaging, there is a relatively limited amount of causal evidence for the role that the TPJ plays in tasks that require switching between representations of the self and other people. This is due to the fact that the

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vast majority of the evidence that was summarised earlier came from correlational studies of brain imaging. There is a lack of consensus about the findings of lesion research that investigate this topic by employing more difficult social cognition tests. For example, Samson et al. (2004) found that three people who had left TPJ lesions showed a diminished ability to participate in theory of mind activities. On the other hand, Spengler et al. (2010) investigated a group of patients who had lesions to either the left or the right TPJ. They discovered that there was no overall decrease in the patients' capacity to control imitation despite the fact that the patients had lesions to either side of the TPJ. They did, however, find a connection between the ability to regulate imitation and performance on tests of perspective-taking in this group. This group was examined for its ability to regulate imitation. In addition, they discovered a tendency toward correlations between a person's capacity to regulate imitation and their performance on theory of mind tests. The fact that these data corroborate the assumption that the TPJ is responsible for maintaining a mechanism that is shared by all of these activities lends validity to that idea. In addition, the findings of these two studies show, in contrast to the conclusions reached by some meta-analyses of imaging data (such as the one carried out by Decety and Lamm in 2007), that the left TPJ may be just as important for social cognition as the right.

When performed on healthy volunteers, brain stimulation techniques such as recurrent transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS) can determine the causal involvement of a specific brain area in a cognitive process. To investigate TPJ involvement in tasks that require switching between self and other representations, these approaches have only been employed in three studies so far. This is due to the fact that both strategies require transitioning between different representations of the self and the environment. After receiving repetitive transcranial magnetic stimulation (rTMS) to the rTPJ, the subjects in both of these investigations exhibited deficits in a variety of aspects of theory of mind function (Costa et al. 2008; Young et al. 2010a; however, the comparison questions in the study by Costa et al. did not control for the complexity of false-belief processing, see e.g. Perner and Leekam 2008, and so the specificity of that effect is unclear). Another recent research improved the cortical excitability surrounding the rTPJ by using transcranial direct current stimulation (tDCS). This was the first study that looked at social cognitive functions other than memory and perception. This resulted in an improved capability to switch between representations of the self and those of others, which had an effect on both the capacity to understand the viewpoint of

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others and the capacity to exercise control over imitation (Santiesteban et al. 2012). Because of this, the first goal of the current study is to expand upon the work done by Santiesteban et al. (2012) by employing rTMS, a method that has a higher level of spatial resolution than tDCS, in order to investigate the causal role of the rTPJ in switching between self and other representations. This will be done by employing a method that has a higher level of spatial resolution than tDCS.

The question of whether the mechanism for switching between representations of the self and representations of other objects is domain-specific or domain-general brings us to a more fundamental level of inquiry. For example, it is well recognised that the rTPJ plays a role in reorienting attention, which is a skill that is useful across a wide variety of different domains (Corbetta and Shulman 2002). Therefore, it is unclear whether the ability to switch between representations of the self and other is a specialised mechanism for social cognition or, alternatively, an example of domain-general attentional reorienting. This is due to the fact that the ability to switch between representations of the self and other has been shown to play a role in social cognition. This is because there has not been a lot of research done on the subject of being able to flip between different representations of the self and other (Mitchell 2008). One part of the problem is that it can be difficult to evaluate social cognition and processing that is domain-general all at the same time using the same test. This is one component of the problem. Two well-known fMRI studies have investigated the topic of whether the involvement of the right temporo-parietal junction (rTPJ) in social cognition is domain-specific or domain-general. Both of these research used functional magnetic resonance imaging. According to the findings of Mitchell, there was a substantial degree of overlap between the neural responses in the rTPJ to social cognition (theory of mind narratives) and domain-general processing (2008; see also Rothmayr et al. 2011). (redirecting one's focus of attention after receiving an incorrect cue) On the other hand, Scholz and colleagues (2009) stated that the apparent overlap was the result of a lack of spatial resolution, and that it is actually possible to assess different brain responses to each of these activities. They came to this conclusion after arguing that it is possible to distinguish between different brain responses to each of these activities. On the other hand, the tasks that were utilised to test social cognition in these research were somewhat different from those that were used to evaluate domain-general processing.

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THE ROLE OF THE TEMPOROPARIETAL JUNCTION IN SOCIAL COGNITION

The involvement of the temporoparietal junction (TPJ) in socio-cognitive processing is the subject of this thesis's second primary research topic, which relates to the neurological basis of self-other images. TPJ participation in social processing has been reported in an overwhelming quantity of neuroimaging research, which led researchers to focus on this particular region of the brain. The region of the cerebral cortex that is at the boundary between the posterior superior temporal sulcus, the inferior parietal lobule, and the lateral occipital cortex is usually referred to by the label TPJ (Corbetta, Patel, & Shulman, 2008).

The TPJ and its role in social cognition

Within the so-called'social brain,' the TPJ is regarded as an important node.1 (Frith & Frith, 2010). A socio-cognitive function may be played by the TPJ, according to the findings of several lines of study, and this function may centre on the processing of representations of the self or another individual. Regarding self-other processing, TPJ activation has been reported during low-level tasks such as agency discrimination (David et al., 2006; Farrer & Frith, 2002), visual perspective taking (Aichhorn, Perner, Kronbichler, Staffen, & Ladurner, 2006), and the control of imitative responses (Spengler et al., 2009), as well as in high level socio-cognitive processes such as mental state attribution (Young, Cushman, Hauser, & Saxe, 2007).

REVIEW OF LITERATURE

Michael S A Graziano (2018) The conduct of experiments that make a distinction between visual attention and visual awareness is not outside the bounds of feasibility. In a research that we conducted not too long ago, we came to the conclusion that there is a link between being awake and being active in a variety of cortical networks that overlap the temporoparietal junction (Webb et al., Cortical networks engaged in visual awareness independently of visual attention). It was discovered in (Taking the attentional confusion out of measuring?), published in Neuroscience and Consciousness in 2018, that we had inadequate control over our attention, which called into doubt the reliability of the experiment. The experiment was in jeopardy as a result of this. Morales et al. We maintain that it is still possible to roughly equate the level of attention between aware and unaware conditions, and that an imbalance in attention is most likely not the reason why our experiments produced the results that they did. Even though we are

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in agreement that attention behaves differently depending on whether or not there is awareness present, we maintain that it is still possible to equate the level of attention between aware and unaware conditions. In spite of the fact that we are in agreement that attention behaves differently depending on whether or not there is awareness present, we contend that it is still possible to roughly equate the level of attention that is present in aware and unaware conditions. This is the case despite the fact that we are in agreement that attention behaves differently depending on whether or not there is awareness present.

Francois Quesque (2019) To be able to have successful relationships with the individuals who comprise our social environment, it is absolutely necessary for us to be able to differentiate between something that originates from ourselves and something that originates from other people. This is because our social environment is comprised of people. However, it is still unclear whether self-other distinction is a mechanism that is involved in a wide variety of social-cognitive functions as a domain-general mechanism or whether specific "self-other distinction mechanisms" exist for each of these functions. It is possible that self-other distinction is a mechanism that is involved in a wide variety of social-cognitive functions. This is due to the fact that it is unknown whether or not the ability to differentiate between oneself and others is a system that is engaged in a wide variety of social-cognitive activities. This is a question for which there is not yet a response that can be considered adequate. There is some evidence to suggest that the temporoparietal junction in the brain is associated to the ability to differentiate between oneself and other individuals. The temporoparietal junction is also known as the temporal-parietal junction. At the intersection of the superior temporal cortex and the inferior parietal cortex, you'll find this particular area (TPJ). In order to provide support for the concept of a domain-general mechanism of self-other differentiation, it would be needed to demonstrate that the TPJ plays a function in social processes that require the distinction between the self and the other. This would have to be done in order for the notion to be able to be maintained. In the current study, we look at evidence that comes from clinical observations, neuroimaging tests, as well as a meta-analysis, in order to establish that the temporal lobe prefrontal cortex is engaged in a range of cognitive operations that need a distinction between the self and the other. This helps us illustrate that the prefrontal cortex located in the temporal lobe is involved. On the perceptual level, we talk about the human capacity to identify one's own body and to differentiate it from the bodies of other individuals. The term "autonomic self-awareness" refers to this

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capacity. On the level of action, we study the research that has been done on the human capacity to perceive agency and the management of imitative response inclinations. Specifically, our research focuses on how humans respond when they see other people doing things that they want to do. To be more specific, we will be concentrating on the connection between the two. At long last, we have arrived at the level of mental state, which is the point at which we examine the capability of recognising the mental states that are present in other persons. On the basis of this in-depth analysis, we propose that the TPJ, and more specifically its dorsal portion, provides a domain-general ability to increase task-relevant representations when self-related and other-related representations are in conflict with one another. This assertion is supported by the fact that the TPJ is located in the temporal pole of the thalamus (TPJ). This argument is based on our assumption that the TPJ is responsible for the bulk of the brain's ability to increase task-relevant representations. This belief underpins this assertion. In conclusion, we are able to give a unified structure, all because of this notion, for the development of a wide variety of socio-cognitive skills and abilities.

Henryk Bukowski (2017) The temporoparietal junction, more frequently referred to as the TPJ, is a heteromodal association cortex that may be found in both hemispheres of the brain at the point where the parietal and temporal lobes meet. The TPJ is sometimes referred to by its more popular name, the temporoparietal junction. It may be found in the region of the brain that is bounded by the temporal lobes and the parietal lobes. The vast majority of the functions that it performs are connected, in some manner, to the attention that an individual possesses as well as their social cognition. Its anterior and posterior parts have distinct connectivity and functional profiles, suggesting that they deal with different high-level processes that contribute, respectively, to monitoring for salient stimuli and reasoning about oneself and others. This is because its anterior parts have more connections between their neurons, whereas its posterior parts have fewer connections. This is due to the fact that the anterior regions of its body have a greater number of connections between their neurons, whereas the posterior parts of its body have a smaller number of connections between their neurons.

RESEARCH METHODOLOGY

Written informed consent was given by twelve naive subjects who were right-handed. Six of the subjects were female, and one was Asian, two were African-American, and one was Hispanic.

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This was done in accordance with the requirements of the Internal Review Boards at Massachusetts General Hospital and MIT. Each participant was a native English speaker and either had normal eyesight or vision that could be corrected to normal levels. In addition, all of the participants were reared in families that were classified as middle class in the United States (for more details, see Section 3.1). Subjects were scanned at a magnetic field strength of 3 Tesla (at a facility located at the Massachusetts General Hospital in Charlestown, Massachusetts) using 26 near-axial slices of a thickness of 4 millimetres each, with the exception of the cerebellum. In functional scans, these parameters were used: TR = 2 s and TE = 40. The story stimuli were modelled after Terwogt and Rieffe (2003) and consisted of eight different variations of twelve different story topics (such as monogamy, violence, and arranged marriage), for a total of 96 stories with an average of 80 words per story. The stories were given to participants in a random order and were read aloud to them. For each aspect of the tale, we developed a design using a 2 2 2 grid. To begin, each story's main character sprang either from a "Familiar" modest Western background or a "Foreign" background (in terms of geography, religion, wealth or politics, see Appendix A for examples). Second, the individual either possessed a "Normal" want or a "Norm-violating" desire, depending on the context. The mental states that were considered "Normal" as opposed to those that violated the norm were determined from the perspective of our participants, and not from the viewpoint of the social group that the protagonist belongs to. Each 'Norm-violating' mental state was fabricated to be consistent with (i.e. conventional from the standpoint of) the 'Foreign' backdrop with which it was paired. This was done in order to ensure that the results of the study would be accurate. In the end, the protagonist either achieved what he or she had set out to do or failed to achieve what they had set out to do. After the scan, we conducted a quick poll to ensure that the participants agreed that their wants were "Normal," and that they found the mild Western surroundings to be "Familiar." The first question that was posed in the poll was, "Which of these categories best characterises you or your family? On a scale of 1 (completely not) to 5 (excellent), how would you rate this? The participants assessed three familiar settings and seven unfamiliar ones. The next question that was addressed in the poll was, "To what extent do you believe or desire each of the following?" On a scale of 1 (completely not) to 5 (excellent), how would you rate this? The participants ranked five typical desires and nine desires that violated social norms. It was ensured that no condition was immediately repeated by presenting the stories in a pseudo-random manner. This

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counterbalanced the order of narrative conditions across runs and across individuals. Participants were exposed to two different versions of each narrative subject, for a total of 24 unique tales. When a tale theme was told more than once, each subsequent telling had a unique protagonist (i.e., a new first name), background, desire, and conclusion from the initial telling of the story. On a black backdrop, the written content of the stories was shown in a white typeface that was 18 points in size. There were three distinct parts to each story's presentation. Initially, for a duration of 6.3 seconds, the screen displayed a series of phrases that provided context to the character. Then, phrases detailing the character's desire were placed onto the screen, and they remained there for another 6.3 seconds to be presented. In conclusion, lines relating to the conclusion of the tale were displayed for 7.4 seconds, bringing the total amount of time the story was shown to the audience to 20 seconds. After then, the tale was taken off the screen, and it was replaced with a probing question that asked, "How would X (the protagonist) feel about this outcome?" Will it be positive or negative?' The words "positive" and "negative" were presented on the left and right sides of the screen (in a counterbalanced sequence), and the participant chose his or her answer by pressing the left or right button on a button box. The query was shown on the screen for a total of four seconds. Each performance consisted of the presentation of twelve different stories. Fixation periods that lasted for twelve seconds each were included in between each narrative. Each round lasted exactly 444 seconds. The experiment was repeated twice for the participants. The same participants were also scanned for a localizer experiment, which compared narratives that needed assumptions about a character's views versus narratives about a physical representation (such an image or map) that had become obsolete. The stimulation and presentation of the narrative were both just as described in the (Saxe & Kanwisher, 2003, Experiment 2).

DATA ANALYSIS AND RESULT

BEHAVIORAL RESULTS

The familiarity score for typical settings was 4.32 out of a possible 5, with 5 being the highest possible result (S.D. 0.72). The average score for those with a foreign background was 1.42 (standard deviation of 0.31, paired-samples t-test: t(1, 10) = 12.14, significance level: p 0.001) When it came to norm-violating wishes, the average agreement that the participants reported was 1.55 (S.D. 0.35, t(1, 10) = 11.30, p 0.001, paired-samples t-test), but when it came to normal

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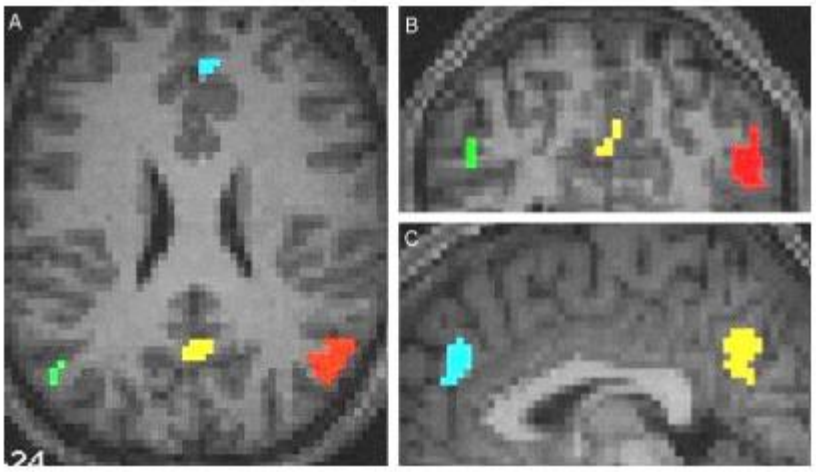
desires, the average agreement was 4.16 (S.D. 0.66). No participant in the study indicated that they strongly identified (>3) with any 'foreign' background or 'norm-violating' opinion. These findings demonstrate that our experimentation with our respondents' perceptions of 'familiar' vs 'foreign' surroundings was successful. Data about the individuals' behaviours were captured while they were in the scanners (behavioural data for two subjects was lost due to technical difficulties). The results of two-way ANOVAs (background by desire) on response times on right trials and on overall percent accuracy showed that there were no main effects or interactions. The following are the reaction times for the four conditions: familiar and normal (1.84 seconds), foreign and normal (1.84 seconds), familiar and uncommon (1.75 seconds), and foreign and unusual (1.79 seconds).

FMRI RESULTS

Localiser experiment

The right temporo-parietal junction was identified in 12/12 subjects with an average peak voxel of 54 54 24; the left temporoparietal junction was identified in 8/12 subjects with an average peak voxel of 48 69 21; the medial pre-frontal cortex was identified in 11/12 subjects with an average peak voxel of 0 60 12; and the posterior cingulate was identified in 11/12 subjects (average peak voxel [3 60 24]). Figure 4.1 displays several examples of interesting locations in the map.



Four 'Theory of Mind' regions of interest (ROIs) in a single representative subject.

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Background

The participants read the first part of each narrative, which consisted of either a "Foreign" or "Familiar" account of the background of one of the characters. We made a comparison of the typical PSC with and without the background information being displayed on the screen (Fig. 2). It was determined that the alteration of the backdrop had no influence on either the RTPJ (familiar background PSC: 0.22, foreign PSC: 0.27, $t(1, 11) = 0.57$, $p > 0.5$) or the PC (familiar PSC: 0.58, foreign PSC: 0.63, $t(1, 10)=.42$, $p > 0.5$). There was a tendency in the same direction in the MPFC (familiar PSC: 0.02, foreign PSC: 0.21, $t(1, 10) = 1.75$, $p = 0.1$), while the LTPJ did respond substantially more to Foreign than to Familiar backdrops (familiar PSC: 0.62, foreign PSC: 0.86, $t(1, 7) = 2.85$, p 0.03).

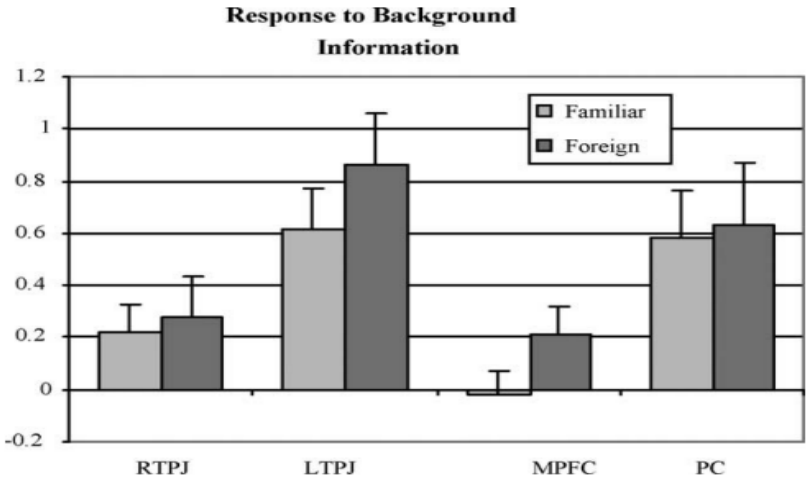

Figure 4. 1 Percent signal change in four 'Theory of Mind' regions of interest, while subjects read about the social background of the protagonist.

We compared the response of each ROI during the first six seconds of the stimulus when mental state information was delayed (as in the current experiment) and when mental state information was available immediately in order to measure the overall response of each region to a protagonist's background (social information with no mental state content). This allowed us to determine each region's contribution to the overall response (the belief stories from the localiser experiment). Both the right temporo-parietal junction ($t(1,11)=9.48$, p 0.001, paired-samples t-test, Fig. 3) and the medial prefrontal cortex ($t(1,10)=3.25$, p 0.01) showed that the impact of delay was extremely significant. There was no impact of delay in the left TPJ ($t(1,7) = 1.71$, $p >$

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0.1) or in the posterior cingulate ($t(1,10) = 0.9$, $p > 0.3$). After using the Bonferroni correction for making multiple comparisons, the only impact that remained was in the RTPJ. According to the findings of repeated measures ANOVAs, the MPFC, LTPJ, and posterior cingulate all had a considerably smaller impact of delay in comparison to the RTPJ (interaction region by delay, all $F > 10.0$, all p 0.01).

CONCLUSION

The collection of research that are provided in this thesis offer a look into self-other processes that are involved in social cognition. These processes have been investigated in the past as a single class of representation (such as mental states, motor plans, and emotional states), which was then "bound" to the socio-cognitive capacity that was being investigated (theory of mind, imitation, empathy). The study investigated whether different acculturation strategies of migrants to a new culture modulate self-other representations in the control of imitation. These social domains include the control of imitation, visual perspective taking, and theory of mind. Underlying mechanisms of self-other representations can be found in all three of these social domains. The findings of Experiment 1 indicate that there is a connection between the ability to control imitation and the ability to take in visual perspective. Furthermore, these data suggest that the underlying mechanism of this relationship may be related to the online control of co-activated self-other representations. This control is supported at the neural level by the TPJ, a region of the brain that has been consistently identified as part of a wider network of regions playing an essential role in social cognition. In addition, these data suggest that the underlying mechanism of this relationship may relate to the online control of co-activated self-other representations. The findings from these trials offer some contribution toward accomplishing that objective, despite the fact that a significant amount of more work has to be done in order to establish the particular role that each component of this network plays. On the basis of these findings, a number of interesting areas for future research have been identified. Among these interesting areas for future research is the potential application of carefully designed behavioural training and brain stimulation protocols in clinical populations that are known to show impairments of self-other representations, such as individuals with autism and schizophrenia.

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