
by

Jennifer Nadine Gutsell

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Psychology
University of Toronto

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Abstract

Similar neural circuits are activated during action and during the observation of action, and such motor resonance is said to support action understanding and could potentially facilitate affect sharing, communication, cooperation and interpersonal coordination. Here I describe a line of research that uses suppression of electroencephalographic mu-oscillations as an indicator of motor resonance to look at motor resonance in an intergroup context. In study 1 I find that group categorization and intergroup biases can restrict motor resonance to the ethnic ingroup, potentially making it unavailable during cross-group interactions. In study 2 I investigate a reduction in affect sharing as a potential consequence of group biases in motor resonance. Using EEG prefrontal asymmetry patterns as an indicator of negative affect and avoidance tendencies, I show that participants do not share the sadness of outgroup members. Finally, I present two studies that test the boundary conditions of the ingroup bias in motor resonance. Study 3 shows that when motivational relevance of the outgroup is increased, because participants are in an inclusive, perspective taking mindset, group biases in motor resonance disappear. Similarly, study 4 shows that when the situation is highly motivationally relevant, such as when the behavior poses a potential threat; people will show motor resonance in response to anyone independent of group membership.
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1 General Introduction

“The opposite of love is not hate, it is indifference.” ~ Elie Wiesel

Humans have an incredible capacity to empathize with others, to understand others’ actions and intentions, to anticipate their next move, their needs, and to use this information to coordinate their own behavior with the behavior of others. When it comes to our loved ones, we use the full extent of our empathic abilities. We automatically catch their moods, emotions, and the meaning and intentions of their actions, which provide us with an intuitive understanding of their inner states. Thereby, we help them when they are in need, we bond with them, and we can act in unison and close cooperation. With those we hate it is different. We still have a need to understand their emotions, actions and intentions, but for more selfish reasons. Here we use our empathic abilities to anticipate our enemies’ next move and to predict their intentions in order to be prepared. Hence, despite our selfish reasons, we still are receptive to the inner states of our enemies. But, what about those towards whom we feel nothing but indifference? Could it be that we do not intuitively catch their intentions, needs and emotions?

Throughout human evolution and historically, people did not have much contact with others outside of their tight social ingroups, and for most people this is still true today (Fiske, 1992). Outgroup members are not the ones we have our most important and meaningful social exchanges with — in a way, most of the time, we can afford to ignore them and to meet them with indifference. Group categorization and biases, thus, could potentially limit the extent to which people are receptive to other’s inner states.
Findings from neuroscience suggest that, at least in part, people understand others’ actions, intentions and emotions through neural resonance: the mere perception of others’ actions (Oberman et al., 2005), facial expressions (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003), and pain (Singer et al., 2006) is matched with neural activity similar to when people perform the action, express their emotions, or feel pain themselves. Neural resonance is associated with better performances in tasks that require emotional empathy (Pineda & Hecht, 2009) and potentially facilitates an intuitive understanding of the other’s actions and emotions (Iacoboni, 2009). In this dissertation I will focus on motor resonance a basic form of neural resonance in the sensory motor system. One way to investigate motor resonance is to use electroencephalography (EEG) to measure neural activity in sensory motor areas during the observation of actions. Here, I present a series of 4 studies that use this method to investigate potential group biases in motor resonance. I propose that, as a default, people do not resonate with ethnic outgroup members; but once outgroup members’ behavior becomes motivationally relevant, either because group boundaries are blurred or because the outgroup member poses a threat, people become sensitive to outgroup members’ inner states. In the following sections I will develop the rationale for this hypothesis.

1.1 Biases in Social Perception

Research in social cognition and social neuroscience has revealed group biases when it comes to processing characteristics and the inner states of others. For example, when research participants believe that a target is an ingroup member, they are better at recognizing the target’s face than when they believe the same target is an outgroup member (the “cross-race effect”; Bernstein, Young, & Hugenberg, 2007; MacLin, Otto & Malpass, 2001). These effects could potentially be explained by the fact that ingroup faces are processed more holistically (their
features are more strongly integrated global representations) than outgroup faces (Hugenberg & Corneille, 2009; Michel, Rossion, Han, Chung, & Caldara, 2006). Not only do people have trouble telling outgroup members apart, they also have difficulty interpreting their facial expressions (Elfenbein & Ambady, 2002a). For example, when Adams and colleagues (2006) examined the neural correlates of emotion recognition, they found that both Japanese and White American participants perform better when judging an ingroup member’s emotional state than when judging an outgroup member’s emotional state, and this ingroup advantage was also reflected in enhanced activity in brain areas involved in emotion decoding. One consequence of these biases in interpreting emotional expressions seems to be that people react less strongly to emotions such as happiness and fear when displayed by outgroup members (Weisbuch & Ambady, 2008). Specifically, pictures of positive and negative facial expressions displayed by outgroup members do not elicit as strong of an affective prime for the evaluation of subsequently presented positive and negative pictures than do pictures of facial expressions displayed by ingroup members. Thus, both the perception of outgroup members’ facial features and their emotional expressions seem to be impaired.

Individuated social perception is not entirely reserved for the social ingroup, however. When an outgroup becomes motivationally relevant, people will be as responsive to outgroup members as they are to ingroup members. For example, Ackerman and colleagues (2006) showed that, although people have problems differentiating outgroup faces, when the faces are angry, people are even better at recognizing outgroup faces than ingroup faces. Similarly, people normally classify multiracial individuals as outgroup members and consequently show decreased performance in recognizing them. When people, however, are motivated to include multiracial individuals in the ingroup they remember them as well as non-ambiguous ingroup members.
(Pauker et al., 2009). Taken together, these findings suggest that people are relatively insensitive to social outgroup members, unless they become motivationally relevant.

Recent findings in the neurosciences are changing our view of person perception. There is growing evidence that person perception involves more than passively collecting visual information and then interpreting it. The mere perception of another’s expressions, mannerisms, and actions inherently brings with it the opportunity for an intuitive understanding of the other that involves not only our visual system, but our motor systems as well. That is, we resonate with the other’s experiences using our own body to gain an active understanding of their actions, intentions and emotions. My goal here is to investigate whether this motor resonance based social perception is also limited by our social categories and group boundaries. I will take a functional approach to motor resonance and explore whether cross-group motor resonance is influenced by motivational relevance of the target.

1.2 The Functional Approach to Person Perception

1.2.1 The human brain as a cognitive miser.

The human environment is highly complex, multifaceted, and rich. People are perhaps the most complex stimuli we encounter and the sheer amount of people we interact with and the diversity of social situations in which these interactions take place, could potentially be overwhelming for a brain with limited cognitive capacity. In order to adapt to the complexity of our world, social and physical, the human mind has developed “tools” to save cognitive resources whenever possible (Macrae, Milne, & Bodenhausen, 1994). Therefore, at each level of cognitive processing, we are always engaged in a selection of what is worth noticing and what is not (VanRullen & Koch, 2003). This selective attention is the process that allows people to focus
on just a subset of all the possible sensory inputs and thoughts (Luck & Vecera, 2002). Where we put the focus of our attention is thus central to any subsequent thought processes; we can only process information further if we actually have been paying attention to it in the first place.

Where we focus our attention, however, seems to be strongly influenced by whether the stimulus is motivationally relevant or not (Moskowitz & Kirk, 2004), and this categorization between relevant and irrelevant is made automatically and in a fraction of a second (Vogt, De Houwer, & Moors, 2011). Therefore, selective attention to motivationally relevant social targets could potentially influence whether people resonate with outgroup members or not.

Whether a stimulus is motivationally relevant can either originate from the stimulus itself, such that some stimuli (e.g., food) are inherently or intrinsically motivationally relevant, or from higher order constructs such as goals. Social stimuli are one kind of stimuli that particularly draws people’s attention, and our brain seems to have developed in a way that makes humans processing experts of various stimuli related to the human body or mind. For example, people show a high degree of visual sensitivity to human movement: When research participants see videos of point lights attached to the major joints of human models, they readily identify different specific human movements (Jacobs, Pinto, & Shiffrar, 2004; Johansson, 1976). Moreover, new born infants prefer looking at faces rather than at other, equally complex stimuli (Johnson, Dziurawiec, Ellis, & Morton, 1991; Turati, Bulf, & Simion, 2008), faces capture attention and distract people from a primary task (Lavie, Ro, & Russell, 2003) and there is a specific area in the brain, the fusiform face area, for processing faces (Kanwisher, Mcdermott, & Chun, 1997). Similarly, people selectively attend to the human body, whether depicted as a true image, as mere silhouettes, or stick figures (Downing, Bray, Rogers, & Childs, 2004). Hence, other human beings seem to be intrinsically salient and important for us and, therefore, capture attention and receive priority in processing over other stimuli. However, not all humans are the
same – people tend to categorize the different people they encounter into subgroups of people and these subgroups might influence just how motivationally relevant another person is to an observer.

1.2.2 Social categorization.

On its quest to save cognitive resources and processing capacity, the brain not only selectively attends to certain stimuli, it also seeks to simplify the environment. Instead of evaluating every situation, or every single person (Fiske & Taylor, 1984) independently, people save cognitive resources by organizing them into category based knowledge structures (Neil Macrae & Bodenhausen, 2001). This means that people do not perceive others entirely in terms of their unique attributes and features. Instead they are strongly inclined to organize them into social categories like race, gender, or age. These categories reduce cognitive effort, because social targets can be evaluated based on their category without having to consider the complexity of the individual. Once these categorical labels are attached to a person, all subsequent cognitive processing is profoundly influenced by them. Consequently, categorical thinking biases what we remember about the other person (Hamilton & Sherman, 1996), how we evaluate the other person, and what impressions we derive of them, leading to stereotypes and prejudice (Fiske & Neuberg 1990). Ultimately, and most relevant for the current purpose, social categorization influences any target-related information that is encountered, even basic attention and perception (Bodenhausen, 1988), potentially even motor resonance.

As noted, the principal function of categorization is to streamline social cognition and to facilitate efficient social interactions by providing useful expectancies that can guide the processing of subsequently encountered information (Macrae & Bodenhausen, 2000). One consequence of this streamlining is cognitive disregard. When people enter a social situation,
they first quickly categorize any new social target into an existing or new social category. These categories can then be used as selection criteria to separate those social targets that are worth further exploring from those who can be disregarded (Rodin, 1987). Disregard, does not mean that the disregarded person is necessarily disliked. Instead, ‘disregard’ criteria define those people who are deemed unsuitable to our currently-active social purpose. For example, the same older aged man could be disregarded by a young woman when her primary goal is to find a partner, but would not be when her primary goal is to make business connections. Thus, our motivations determine which social categories can be disregarded and which we should attend to. This becomes problematic, however, when certain categories are inherently prone to disregard so that people in these categories are treated with indifference in most situations – they no longer are intrinsically motivationally relevant. One such category seems to be the category “social outgroup member”.

1.2.3 Cognitive disregard for social outgroups.

According to social identity theory (Tajfel, 1982; Turner, 1975), individuals are generally motivated to achieve a positive self-esteem and because personal self-esteem is tightly related to one’s group identity, self-esteem can be enhanced by a positive evaluation of one’s own social group. One’s own group, however, can only be evaluated in comparison with an outgroup. Thus, people are strongly motivated to establish a positively discrepant comparison between the ingroup and a relevant outgroup. In order to achieve this, they readily categorize their social environment into “us” vs. “them” or ingroup vs. outgroup. The ingroup and outgroup status of people, thus, exerts a powerful influence on social cognition (Allport, 1954).

In order to have a clear ingroup vs. outgoup distinction people tend to exaggerate the differences between the ingroup and the outgroup (Tajfel, 1978), and importantly, they tend to
see the members of an outgroup as more homogeneous and similar to one another than members of the group perceive themselves (Park, Judd, & Box, 1990). Therefore, while people think that ingroup members are very distinct and thus require careful consideration, outgroup members are seen as all the same and thus it is deemed safe to save resources by assuming their traits, goals, and intentions are stereotypical. People might be particularly susceptible to make these kinds of assumptions, because they often mistakenly think that social categories are essence-based groupings, in the sense that some underlying essence that all category members have in common distinguishes them from members of other categories. That is, people conceive of many social categories as if they were more like biological categories such as different kinds of species, and not the social and cultural constructions they really are (Rothbart, & Taylor, 1992). Along with such an essentialist view of social categories, then, comes the assumption that the category has inductive potential (Haslam, Rothschild, & Ernst, 2000).

Taken together, people are strongly motivated to make the ingroup/ outgroup distinction and to categorize new interaction partners into either the ingroup or the outgroup. Once others are categorized into an outgroup, they are no longer considered as individuals, but simply as part of a category. Consequently, when the outgroup as a whole is not considered motivationally relevant, each individual will automatically be the target of cognitive disregard. Moreover, the outgroup category itself is likely to be the target of cognitive disregard, because throughout human evolutionary history and even nowadays the ingroup and not the outgroup was most important for goal attainment.

From an evolutionary perspective, ingroup members are more beneficial for one’s reproductive fitness. According to the concept of inclusive fitness (Hamilton, 1994), individuals can promote their own evolutionary success by helping others who share some of their genes.
(Sime, 1983). The degree of genetic overlap, however, is impossible to detect, and thus people have to use proxies of genetic overlap such as the degree of kinship, similarity, familiarity, and affiliation. Moreover, people need other people for survival. From the perspective of a hunter-gatherer, being excluded from the group was life threatening. In a hunter-gatherer society, survival alone was nearly impossible, and even today, lasting, meaningful relationships are essential for well-being (Baumeister & Leary, 1995). Ingroup members are usually the ones with whom we most often interact; when we interact with outgroup members it is mostly at a group level rather than in one-on-one intimate interactions (Fiske, 1992). Consequently, shared social understanding and effective social interactions with other group members are essential (Caporael, 1997). If one depends on another person, one needs to understand him or her as an individual. It would, thus, make sense that humans are particularly attuned to ingroup members, that we devote much cognitive effort into perceiving and understanding ingroup members and their intentions, actions and motives. The other side of the coin would be that, since most of the time we can afford to ignore the outgroup and to treat outgroup members with indifference; we would be less sensitive to outgroup member’s inner states and less attuned with their actions. I propose that even motor resonance, the most basic mechanism underlying the understanding of other’s inner states, is reduced when it comes to processing outgroup members. In the following sections, I will explain motor resonance and how it can be measured in more detail.

1.3 Motor Resonance

A now classic effect in social psychology is that perceiving someone else’s behavior increases a tendency in the perceiver to behave similarly (Chartrand & Bargh, 1999). This happens because actions and the mere perception or imagination of the same action share common neural representations (Preston & de Waal, 2002; Prinz, 1987). In the brain, this action-
perception link is said to be implemented by the so called mirror neurons; a subset of sensory motor neurons that are active during motor activity, but also when the perceiver remains completely still and sees someone else engaging in motor activity (Carr et al., 2003; Rizzolatti & Craighero, 2004). Mirror neurons were discovered using single cell recordings in monkeys, but single cell recordings in humans are hard to get due to ethical considerations, and thus far only one study has shown mirror neurons in humans using single cell recording (Mukamel, Ekstrom, Kaplan, Iacoboni, & Fried, 2010). Because of the ethical considerations, mirror neuron activity in humans is usually investigated using corresponding neural activation of sensory motor areas within an observer in response to the mere perception of motor activity in the target as a proxy.

The precise location of the mirror neuron system in the human brain is still a matter of debate. Traditionally, researchers restricted the mirror neuron system to sensory motor areas, specifically to a network consisting of ventral and dorsal premotor cortex, anterior inferior parietal lobule and adjacent somatosensory area BA2, and the middle temporal gyrus (Keysers, Kaas, & Gazzola, 2010). These brain areas are normally associated with planning, preparation, execution, and proprioception of our own actions (Schippers & Keysers, 2011). However, indirect measures of neural activity and single cell recording support the existence of neurons with mirroring properties also in other motor regions, and also in non motor regions. For example, Mukamel and colleagues (2010) recorded activity from 1177 cells in the human medial frontal and temporal cortices while patients executed or observed hand grasping actions and facial emotional expressions. They found a significant proportion of neurons with mirroring capacity in the supplementary motor area, the parahippocampal gyrus, and the endorhinal cortex – areas usually involved in movement initiation and sequencing and memory, and not traditionally categorized as part of the mirror neuron system. Nonetheless, these areas might contribute to the vicarious experience of others’ action and emotional states.
Because for single cell studies in humans, researchers are limited to certain brain areas based on clinical need, most areas of the brain have never been directly investigated for the existence of neurons with mirroring capacity. Hence, future research might discover that the mirror neuron system is a much wider network than previously thought of, and might not at all be limited to the brain’s motor regions. Research using functional magnetic resonance imaging (fMRI) gives some indication on to which brain functions might involve mirror neurons. Thus far, shared neural networks have been inferred for the perception and experience of disgust (Wicker et al., 2003), pain (Singer et al., 2004), touch (Keysers & Perrett, 2004), and facial expressions (Carr et al., 2003). Neural resonance, thus, might be essential for a number of forms of interpersonal sensitivity, including emotional contagion and empathy (Singer et al., 2006). For the current purpose, however, I will focus on the traditional mirror neuron system that has been extensively researched in monkeys and more recently in humans using motor resonance as a proxy of mirror neuron activity. Although still under some debate (Gallese, Gernsbacher, Heyes, Hickok, & Iacoboni, 2011) the motor-mirror neuron system is thought to be involved in the understanding of others actions and intentions (e.g. Iacoboni, 2005; Oberman, Pineda, & Ramachandran, 2007).

1.3.1 Motor resonance and action understanding.

Mirror neurons were discovered only relatively recently (Umiltà et al., 2001), and consequently our knowledge about them and their specific functions is still limited. Although it is now widely accepted that mirror neurons exist in the macaque monkey and also in the human brain, the field is still divided when it comes to the specific function of these neurons (Glenberg, 2011). From the very start mirror neurons have been linked to many different social phenomena including action understanding, language comprehension, imitation, and empathy (Decety,
2010; Gallese et al., 2011; Hickok, 2009), but action understanding is often seen as the core function of mirror neurons (Hickok, 2009). Moreover action understanding is probably the function most addressed, both by empirical research and in theoretical discussions (Hickok, 2009), and the field seems to have reached at least some consensus on whether mirror neurons are involved in action understanding (Glenberg, 2011). For these reasons, I will limit discussion on the function of mirror neurons to action understanding.

Summarizing a discussion between proponents and opponents of the mirror neuron theory of action understanding (Rizzolatti & Craighero, 2004), Celcilia Heyes commented: “So what is the dispute really about? My guess is that it concerns, not what causes action understanding, but what constitutes action understanding,’”(Gallese et al., 2011). Heyes stresses the importance of a clear definition of motor resonance, and alludes to the fact that much of the debate is caused by a lack of agreement on what action understanding actually is. Many mirror neuron researchers use a very restricted definition of action understanding. For example, Gallese and colleagues (1996) define action understanding as:” The capacity to recognize that an individual is performing and action, to differentiate this action from others analogous to it, and to use this information in order to act appropriately” Similarly, Rizzolatti (2001) defines action understanding as follows: “The capacity to achieve the internal description of an action and to use it to organize appropriate future behavior”. Such a basic form of action understanding is stripped of most higher order cognitive processes, such as inferences about intention or the capacity to name or to make logical inferences about the action. Instead, action understanding, defined in this basic sense, is more of a hunch and intuitive sense of the semantics of the action, i.e. what the action is about, what its goal is, and how it is related to other actions, than true understanding in the usual sense. Different perspectives on what action understanding is have the potential to cause conflict. For example, a common objection to the mirror neuron theory of
action understanding is that we can understand actions that we cannot perform (Hickok, 2009). If mirror neurons were indeed involved in action understanding, why is action understanding not impaired by a lack of previous experience with the action; obviously someone who never played tennis can still understand that the player is hitting the ball. However, this objection reflects the belief that action understanding is a much more complex and cognitive process than assumed by many supporters of the mirror neuron theory of action understanding. The more basic form of action understanding comes from personal experience and this more personal understanding would be missing when people observe actions they never performed themselves. The inexperienced observer might be able to grasp that the player is hitting the ball, but he will not be able to feel what it is like to hit the ball, and thus will have a harder time to predict the direction, speed, and placement of the ball (Gallese et al., 2011). Such an intuitive understanding based on experience could be independent from other, higher order and more cognitive forms of understanding (Gallese et al., 2011).

There is empirical evidence for the involvement of motor resonance in a basic understanding of actions and intentions. For example, research shows that motor resonance goes beyond the mere mechanics of a motion, but seems to map the function and goal of the action; Mirror neurons fire, even when the “observer” can only partially (Umilta et al., 2001), or not at all (Kohler et al., 2002) see the action. Moreover, motor resonance is more pronounced for goal directed action (Cattaneo, Caruana, Jezzini, & Rizzolatti, 2009) and specific groups of mirror neurons respond to specific and unique goals of actions (Gallese et al., 2011), such as grasping to put something into a container vs. grasping to bring something to one’s mouth (Bonini et al., 2010). Another indication that mirror neurons code more than the visual features of the action is that actions, absent from the person’s motor repertoire, are not mirrored. Research participants in an fMRI experiment showed activation in equivalent motor regions during the observation of
biting and lip smacking, but not of barking – a behavior that is not in the human motor repertoire (Buccino et al., 2004). Finally, mirror neurons fire in response to sounds of actions, suggesting that they code the meaning and not only the visual features of the action (Kohler et al., 2002).

In addition Keyser and Perrett’s hebbian model of mirror neurons (Keysers & Perrett, 2004) provides an explanation for how such an intuitive understanding of the action semantics, could be acquired through motor resonance. According to this model, mirror neurons acquire their mirroring properties through Hebbian learning (Keysers & Perrett, 2004). That is, as infants move their own limbs they observe themselves. Throughout the repeated coupling of action execution and the visual aspect of the action, neurons that fire in response to the observation and motor neurons that fire during execution form Hebbian associations. Soon these associations become so strong that previously motor neurons will also respond during observation, making them visiomotor neurons. Similarly mirroring of facial expressions could have evolved though the recurrent pairing of the child expressing emotions and the imitation of the child’s facial expressions by the parent. Once the connections have been established the information flow can go forward and back – visual information can affect motor areas and motor activity can affect perception. This bidirectional information flow could play a key role in the transformation from observing an action to simulating this action internally and predicting its sensory consequences (Schippers & Keysers, 2011). For our own actions, this mechanism could be essential for action control: During execution, the system sends an efferent copy of the action to sensory areas to predict sensory and proprioceptive consequences of that action. Then, if the actual sensory information and the predicted sensory consequences differ, the action can be adjusted. When we observe others, this system could achieve an interpretation of the observed action by first simulating the action in the premotor cortex and then predicting the sensory consequences of the internally simulated action (Schippers & Keysers, 2011). The critical point here is that the
simulation of the observed action not only allow us to predict others’ actions and action consequences, it could potentially also bring about knowledge of the internal state of the other that is associated with the action.

We only have a limited understanding of the nature of these vicarious experiences, but there are some clues from studies using electrical brain stimulation in awake surgical patients (Keysers et al., 2010). For example, stimulating the premotor cortex elicits overt movement, but the patients do not realize that they actually move (Desmurget et al., 2009). Stimulating the inferior parietal lobule creates a strong intention to move, but the patient does not actually move (Desmurget et al., 2009). Finally, stimulation of the somatosensory cortex elicit the sensation of movement and other somatosensory qualia (Desmurget et al., 2009). Theoretically, when we observe others’ actions, the different areas of the sensory motor system could each contribute a different aspect to the understanding of the action, such as sensing the intentions of others, experiencing what it might feel to move, predicting their next move and also preparing our own motor response (Keysers et al., 2010).

The notion that action understanding could be the result of joint activity in different areas within the sensory motor system including areas that contain mirror neurons and those that do not, is interesting. That’s because the existence of non-mirror regions that are involved in action understanding has been perceived as a threat to the notion that mirror neurons themselves code the semantic properties of the action (Hickok, 2009). The reason is that such non-mirror regions could potentially process the meaning of the action and, at the same time, activate motor neurons, creating the impression of mirroring. For example, neurons in the superior temporal sulcus (STS) seem to code much more complex aspect of actions then mirror neurons. Moreover, while these cells do not have motor properties, they provide input into the motor regions that
contain mirror neurons. Because of these connections it could look like mirror neurons code action semantics, when in fact they would not (Hickok, 2009). Once we allow for non-mirroring and mirroring regions to jointly contribute to action understanding, we can focus less on what individual mirror neurons code for and instead regard the entire network. In addition, such a divers system could also be involved in a variety of motor related functions. One such process seems to be action preparation. Based on the theoretical arguments and empirical findings discussed above, there are good reasons to believe that motor resonance is involved in a basic form of action understanding, but there are also findings suggesting an involvement in action preparation (Fadiga, Fogassi, Pavesi, & Rizzolatti, 1995; Tkach, Reimer, & Hatsopoulos, 2007). In any case, both are not mutually exclusive processes, and they could, therefore, both be related to motor resonance, each contributing to important social functions such as smooth interactions, cooperation and action coordination.

In sum, even though other higher order cognitive processes are involved in action understanding, motor resonance could add an implicit and deeper understanding that comes from personal experience. Without this first person perspective, visual information alone would not provide us with the information critical to understanding what it means to undertake the action, how it relates to other actions, and to predict the others next move. If we would resonate less with outgroup members, we could potentially have a harder time coordinating our actions with theirs, predicting their actions, and understanding their intentions. In what follows, I will describe a series of studies that investigate how group categories, ingroup biases, and motivational relevance influence the amount of motor resonance in response to others. In most studies reported here I used suppression of electroencephalographic mu oscillations during the observation of actions as an index of motor resonance.
1.4 Mu-suppression as a Measure of Motor Resonance

The mu-rhythm is a well established measure of neural activity in the sensory motor cortex (Kuhlman, 1978; Pfurtscheller, 1979). The alpha component of the mu-rhythm (8-12 Hz) seems to originate from primary somatosensory cortex (Hari, 2006) and shows a synchronized activity at rest, which is desynchronized, both during movement and during passive observation of movement, leading to a suppression of mu (Pineda, 2005). During execution of movement, neurons in the premotor, motor, and sensorimotor cortices are activated (Pineda, 2005). Therefore, mu-suppression while a person is moving is probably the result of motor neurons and mirror neurons. In the absence of overt movement, theoretically motor neurons should no longer be active, leaving only mirror neurons to contribute to mu-suppression (Pineda, 2005). Mu-suppression during action observation should, therefore, be exclusively attributed to the discharge of mirror neurons. Anatomically mirror neurons, located in the ventral premotor cortex could affect neurons in the primary sensorimotor cortex through existing strong connections between these two regions, resulting in mu-suppression (Pineda, 2005).

In sum, the phenomenology of the mu rhythm is very similar to the phenomenology of mirror neuron activity in that both are sensitive to movement and the mere observation of movement. Moreover, the anatomical configuration of the motor system and the mirror neuron system specifically are consistent with the possibility of a downstream modulation of sensory motor neurons by mirror neurons, which could be reflected in the the mu-rhythm originating in sensory motor cortex. Mu-suppression, thus, seems to be a good indicator of motor resonance and mirror neuron activity (Puzzo, Cooper, Cantarella, & Russo, 2011).
1.5 Overview

In what follows, I will describe four studies that use EEG mu-suppression to investigate motor resonance in an intergroup context. My strategy throughout was to use videos of ingroup and outgroup members as target stimuli, and ethnicity as the defining factor for group membership.

In chapter two I will describe a study that was aimed to test the general effect of an ingroup bias in motor resonance. I presented participants with videos of ingroup and outgroup members and measured participants’ levels of motor resonance during action observation. Taking a functional approach to motor resonance, I expected that by default people would only show motor resonance in response to seeing members of their ingroup performing an action, and not in response to the actions of outgroup members. Moreover, I expected that such an ingroup bias in motor resonance would be aggravated by prejudice and for disliked outgroups.

Once the first study established that there indeed is a group bias in motor resonance, the study described in chapter three tested one potential consequence of such bias – reduced affect sharing with outgroup members. I used asymmetries in the suppression of prefrontal alpha-rhythms as an indicator for negative, avoidance related affect in response to displays of sadness. I predicted that participants would show alpha asymmetry patterns related to negativity when looking at sad ingroup members, but not when looking at sad outgroup members.

In chapters four and five I then describe two studies that aimed to increase motor resonance for outgroup members. In the first of the two studies, participants took the perspective of an outgroup member, or adopted and objective mindset before they saw ingroup and outgroup members performing actions. I expected that perspective taking would alleviate the ingroup bias
in motor resonance, leading to resonance for outgroup members. In the final study, I looked at the effects of action intent on motor resonance for outgroup members. Participants watched videos of ingroup and outgroup members performing neutral, positive, and neutral actions. I expected only threatening outgroup behavior to elicit motor resonance in the observer, because of its high level of motivational relevance.
2 Group biases in motor resonance

People are sensitive to others who fall within a closed circle defined by their social relations; and members of outgroups are excluded from this circle (Turner et al., 1979). When people connect with others, they resonate with them by adopting their postures, intonations, and facial expressions. I suggest, however, that motor resonance is linked to the ingroup, thus making it comparatively difficult to respond to the feelings, intentions, and needs of those categorized as members of an outgroup. Measuring the neural processes involved in action understanding, this study directly investigates how the basic building blocks of interpersonal sensitivity are affected by group membership and social biases. Specifically, I propose that people are less likely to resonate with the simple actions of others when those others belong to a disliked outgroup. I also propose that this reduced mental simulation will be exacerbated for those who are high in prejudice.

2.1 Bounded Interpersonal Sensitivity

Neural resonance in a broader sense seems to be subject to social factors. When observing others in pain, people show activity in brain areas associated with the experience of pain only for others they like and not for those they dislike (Singer et al., 2006). Similarly, participants show diminished neural activation of pain circuits when observing ethnic outgroup members in pain relative to ingroup members (Xu, Zuo, Wang, & Han, 2009).

Behavioral research also supports the idea of motor resonance being bound to the ingroup. Although people mimic others’ expressions, gestures, and body postures, this occurs with less frequency for outgroup members (Likowski, Mühlberger, Seibt, Pauli, & Weyers,
2008). These findings suggest that the link between perception and action is weaker when it comes to outgroups, but falls short of showing how exactly this occurs. I aim to fill this gap by taking a direct look at motor resonance online, while people passively observe the actions of ingroup and outgroup members. By measuring neural activity during observation and action, I aim to measure potential group biases in motor resonance.

Research on prejudice has shown that our attitudes bias how we perceive and process others’ behaviour. Recall that we have a harder time to recognize outgroup members’ faces (Sporer, 2001) and to interpret their facial expressions (Elfenbein & Ambady, 2002b); outgroups are also less likely to activate neural areas for social cognition (Harris & Fiske, 2006) and social perception (Van Bavel, Packer, & Cunningham, 2008). Given these biases in social perception and processing it follows that we would be less sensitive to the actions, intentions, and thoughts of outgroup members—something that should be reflected in the neural networks that implement motor resonance. It also follows that the more we dislike outgroups—the more prejudiced we are—the less we will show neural evidence of simulation.

2.2 Overview

We used EEG recordings to compare brain activity during the experience and observation of actions, and used suppression of EEG oscillations in the 8-13 Hz mu frequency at scalp locations over primary motor cortex as my main dependent measure. I predicted that participants would show less mu suppression in response to outgroup members than to ingroup members and that this difference in vicarious mu suppression would be stronger with increasing prejudice. Sociological research (Kalin & Berry, 1996) indicates that Canadians of South Asian descent belong to the least valued ethnic groups in Canada. Thus, while I expected less motor resonance
for the average of all outgroups, I predicted the least motor resonance when observing South Asians, followed by Blacks, and then by East Asians, who are generally not disliked in a Canadian context.

### 2.3 Methods

#### 2.3.1 Subjects and Design

We originally sampled 37 White participants, but excluded seven because some were left handed ($n = 3$), self identified as non-White ($n = 2$), because of system malfunction ($n = 1$), or incomplete data ($n = 1$). My final sample thus included 30 White, right-handed University of Toronto Scarborough students (13 female; $M_{\text{age}} = 18.46, SD = 3.81$), who participated for course credit. Participants completed three conditions in a one-way within subject design: ingroup, outgroup and self condition. I defined ingroup as people who share the participant’s ethnic identity (Caucasian), and outgroup as people who did not (African-Canadian, East-Asian, South-Asian).

#### 2.3.2 Procedure

Upon arrival in the lab, participants provided informed consent and were then fitted with and electrode cap for EEG recording. I recorded 120 seconds of baseline EEG activity over motor areas while participants were sitting still looking at a white screen. EEG was then recorded while participants passively watched a set of videos. The videos showed a variety of ingroup and outgroup members performing a simple action. After watching the videos, participants were asked to perform the action themselves.
2.3.3 Material

2.3.3.1 Symbolic racism scale.

During a mass testing session in an introductory psychology course, participants completed the Symbolic Racism Scale (Henry & Sears, 2002) — a measure of modern racism, indicative of a subtle form of racism that obscures racist feelings with abstract values, such as justice and order.

2.3.3.2 Video-set manipulation.

Participants saw videos depicting members of different ethnic groups (Caucasian, East-Asian, South-Asian, and African-Canadian) performing an action. The videos showed university-aged male actors sitting at a table in front of a white wall with a glass of water in front of them. Displaying a neutral face, the actors repeatedly reached for the glass, picked it up, took a small sip of water, and then put the glass back in its place. In the ingroup condition, participants saw three different Caucasian actors, each performing the action for 10 seconds. In the outgroup condition, the participants saw three different actors of each ethnic outgroup perform the action for 10 seconds.

To control for other differences in the videos, I presented screenshots of each of our videos to a different sample of 33 introductory psychology students (25 female) and asked them about their impressions. Specifically, I asked participants to rate the screen-shots in terms of video quality (ingroup: $M = 2.52, SD = .61$; outgroup: $M = 2.49, SD = 0.54$), attractiveness (ingroup: $M = 1.68, SD = .57$; outgroup: $M = 1.70, SD = 0.65$), likability (ingroup: $M = 2.11, SD = .68$; outgroup: $M = 2.20, SD = .68$), and racial group typicality (ingroup: $M = 2.52, SD = .61$;
outgroup: $M = 2.49, SD = .54$) on a 5 point Likert scale. Results revealed no significant differences across any of these variables, all $p_s > .21$, $ns$.

Figure 1 shows a graphic depiction of the experimental design. In total, I obtained 30 seconds of EEG data during the ingroup condition and 90 seconds during the outgroup condition with 30 second blocks for each of the three different ethnic outgroups. The blocks of the four different ethnic groups where presented in random order and the order of individual actors within each block was also randomized. Thus each ethnic group and each actor within each ethnic group was presented in a random order. Near the end of the session, participants performed the same action themselves for 30 seconds.

**Figure 1:** Outline of experiment design: first participants completed a 120 s baseline measure. Following, participants completed three conditions: outgroup, ingroup and self condition. In the ingroup condition, participants saw three 10-s videos of people who shared the participant’s ethnic identity (Caucasian). In the outgroup condition they saw three 10-s videos of each ethnic outgroup (African–Canadian, East Asian and South-
Asian). The ingroup and outgroup condition appeared in randomized order and where followed by the self condition during which participants performed a simple action for 30 s.

2.3.4 Electrophysiological Recording and Processing

To measure mu rhythm, I recorded the EEG from 32 Ag/AgCl sintered electrodes embedded in a stretch-lycra cap. Recordings were collected according to the 10-20 system with a band pass filter at 0.1 - 100Hz and a notch filter at 60 Hz. The EEG was digitized at 512 Hz using ASA acquisition hardware (Advanced Neuro Technology, Enschede, the Netherlands) with a digital average earlobe reference. Vertical eye movements (VEOG) were monitored using a supra-to sub-orbital bipolar montage and the continuous EEG recordings were corrected off-line for eye-blinks using the VEOG channel and the Second Order Blind Identification (SOBI) procedure which is a signal processing method for isolating and removing ocular artifacts (Tang, Liu, & Sutherland, 2005). During recording, the impedances were kept below 5 Kohm. Continuous artefact-free epochs of 2.0s from each interval were extracted through a Hamming window and overlapped by 75% to minimize data loss. I performed fast Fourier transformation and calculated power in the 8-13 Hz band for 10 seconds for each ethnic group and 10 seconds for self-action. I averaged the spectral data over the three outgroups and then created mu suppression index scores for each condition by calculating the log ratio of mu power during that condition over mu power during baseline. A log-ratio score was used to normalize the data and to control for individual differences in absolute mu power due to differences in impedance, and scalp thickness. I did this for all electrodes. However, because all participants performed the action with their dominant right hand I performed statistical analysis only for electrode C3.
located over the contra lateral, left primary motor area. More negative scores indicate a stronger suppression of the mu rhythm and, hence, more cortical activity.

2.4 Results

We created log-ratio scores (log mu power during action / log mu power during baseline) for all conditions. As expected, the self-action log-ratio scores ($M = -.33, SD = .40$) were significantly different from zero, $t (29) = -4.44, p < .01, d = 0.83$ indicating that participants showed mu suppression and suggesting an increase in motor cortex activity during motor action compared to the motionless baseline condition. To compare mu-suppression during the different conditions I conducted a within subject ANOVA over the three conditions (self, ingroup and outgroup) which resulted in a significant main effect of group $F (2, 28) = 9.20, p < .01$. 
Figure 2: EEG mu suppression at left central scalp location (C3) during action and during the observation of ingroup and outgroup members. Error bars represent ± 1 standard error. Negative numbers denote more mu-suppression (i.e. more neural activity) at C3

Figure 2 illustrates that the data confirmed my hypotheses. Participants showed increased mu suppression when passively observing ingroup members ($M = -.06, SD = .13$). Although these log-ratio scores were significantly different from self-action, $t (29) = -3.97, p < .01, d = 0.76$, critically, the increase was significantly different from zero, $t (29) = -2.40, p < .03, d = 0.46$. This suggests that there was motor cortex activity when participants passively observed ingroup members. Importantly, participants showed no activity over motor areas when they observed outgroup members ($M = -.01, SD = .13$), $t (29) = -0.03, p = .77$, a level of activity that was significantly lower than while observing ingroup members, $t (29) = 2.12, p < .05., d = 0.38$. These findings suggest that participants did not resonate with the actions of outgroup members.
The analysis also revealed a significant linear trend, $F (1, 29) = 9.47, p < .01$, indicating the most mu suppression during the self condition, followed by the ingroup, and finally the outgroup condition. This linear trend, however, was subsumed under a significant quadratic trend, $F (1, 29) = 17.91, p < .01$, reflecting much stronger mu suppression during action than during observation of action.

Subsequent analysis revealed a marginal difference between the three different outgroups, $F (2, 28) = 3.05, p = .06$, such that participants showed more mu suppression for East Asians ($M = -.04, SD = .15$), followed by Blacks ($M = -.03, SD = .15$), and then South Asians ($M = .02, SD = .16$). Importantly, participants did not show significant mu suppression when observing any of the outgroups (all $p$s > .14), thus justifying my a-priori decision to average across groups. However, the marginal difference between them suggests different levels of mu suppression for each group. Interestingly the degree of mirroring neatly reflects the distinct Canadian context, where South Asians’ tend to have lower status than Blacks, and where East Asians are seen as a model minority (Kalin & Berry, 1996).

Additional analyses confirmed that prejudice was inversely correlated with activity at scalp locations over motor cortex in response to outgroup members. The more prejudiced participants were, the less mu suppression they showed in response to outgroups $^1$, $r (28) = .52, p$

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$^1$ 1. Note that mu suppression is coded such that negative values indicate more suppression (i.e. more motor cortex activity). A negative association between mu suppression and prejudice, therefore, appears like a positively valued correlation.
< .01 (see Figure 3). In contrast, I found no such correlation for the ingroup condition \( r (28) = .18, p = .36 \), two correlations that are significantly different from one another, \( Z = 1.83, p < .035 \) (one tailed). When I breakdown the omnibus outgroup correlation into the specific racial outgroups, I find results that are consistent with a Canadian context: The correlation was strongest for South-Asians, \( r (28) = .56, p < .01 \), and followed by Blacks, \( r (28) = .36, p = .05 \); the correlation for East-Asians, however, fell below traditional levels of significance, \( r (28) = .30, p = .11 \). Since mu activity is inversely related to motor cortex activity, these findings suggest that the more participants are prejudiced, the less their motor cortex fires in response to the passive viewing of outgroup members’ actions — an effect that is magnified for disliked outgroups (South Asians, then Blacks, followed by East Asians).
**Figure 3:** Scalp topography of the correlations between mu suppression for outgroups and prejudice. Darker grey indicates scalp locations for which mu suppression is positively correlated with symbolic racism scores. Due to the inverse relationship of mu suppression and motor activity, this depiction indicates that less motor activity in left parietal areas is associated with higher levels of prejudice.

### 2.5 Discussion

These data suggest that people resonate less with the actions of outgroups. That is, those neural networks involved in the simulation of actions and intentions — most likely part of the “mirror-neuron-system” — are less responsive to outgroup members than to ingroup members. I take this as evidence that people experience less vicarious action and their associated somatic and autonomic states when confronted with outgroups than with ingroups. Especially, prejudiced people failed to resonate with outgroup members’ actions and this failure to resonate was
particularly pronounced for disliked outgroups. This suggests that people — but especially people high in prejudice — do not intuitively grasp outgroup members’ intentions and actions. I interpret this correlation with caution, however. While a natural deficit in outgroup-action simulation can contribute to prejudice, it is also likely that prejudiced people do not resonate with outgroup members because of their biases and dislikes. Specifically, prejudice might bias attention against outgroups thereby impairing motor resonance.

A deficit in the spontaneous “catching” of outgroup members’ actions and intentions could have serious consequences for intergroup interactions. Motor resonance could potentially facilitate social understanding and social coordination and thereby might improve interactions. Thus, due to the lack in motor resonance, people might not be as responsive to outgroup member’s inner states and less likely to understand their actions and effectively communicate with them.

In addition to the consequences of lacking an intuitive action understanding intergroup interactions might also suffer from a lack of affective sharing. The perception action model of empathy (Preston & de Waal, 2002), connects action understanding with affect sharing by proposing a common mechanism – the perception action link. According to this model social animals and especially primates, who rely heavily on their conspecifics for survival, use the action perception link in various ways to navigate through their complicated social systems (Preston & de Waal, 2002). When someone observes another, the observer has access to the target’s inner states, because the mere observation activates the same neural and bodily representations in the target. This is not only true for the observation of actions, which brings about representations of the experience of performing the action, but also for the observation of facial expressions which brings about representations of the other’s affective and motivational
states. As proposed in the facial feedback hypothesis (Izard, 1990; Laird, 1984), once the observer overtly adopts the object’s expressions and posture, these elicit bottom-up processes that elicit the correspondent emotions. In the same way, and independent of overt mimicry, neural motor resonance with the objects facial expressions would activate the associated neural networks for the experience of these emotions enabling the observer to share the affective and motivational states of the target. This emotional contagion is the most basic process in empathy (Atkinson, 2002). Hence biases in motor resonance could potentially also translate into biases in the sharing of somatic, autonomic, and ultimately emotional and motivational states during intergroup encounters. I aimed to test this possible implication of biases in motor resonance in a study looking at neural signals associated with the experience of negative affective states and avoidance motivation.
Prejudice is an ongoing problem in human societies, with humans committing some of the most hateful acts because of their prejudices, including acts of discrimination, segregation, and even wars and genocides. At the same time, humans are truly empathic creatures: One-day old babies cry when they hear other babies cry (Sagi & Hoffman, 1970), and the recent discovery of mirror neurons and neural resonance suggests that we intuitively “catch” and “match” other’s emotions and actions by mere observation. Humans, it appears, have a natural instinct to connect with others and to share their emotions.

Does this natural tendency to share others’ emotions occur for our social outgroups? Here I propose that although people can easily pick up others’ emotions (possibly a precursor to empathy), they are less likely to do so when that other belongs to an outgroup. By looking at prefrontal alpha asymmetry in response to ingroup and outgroup members’ negative emotions, this study investigates whether people resonate less with members of social outgroups than ingroups and whether this bias in empathy is intensified by increasing levels of prejudice. First, I define what I mean by empathy.

3.1 The Nature of Empathy

Empathy is the ability to share others’ emotions (Preston & de Waal, 2002), or more specifically, an affective response more appropriate to another’s situation than one’s own (Hoffman, 2000). Note though, that emotional sharing seems to be only the first step of the full blown empathic response, which requires at least minimal realization that the emotions one is
feeling are caused by the other (Jean Decety & Jackson, 2004). Affect sharing without self-other distinction is considered less empathic because it is not other-oriented. For example in a lab experiment, rats failed to press a button to save another rat that suffered from electric shock and instead crunched fearfully in the furthest corner expressing high levels of distress (Rice, 1962). The next evolutionary step after affect sharing and the next step in child development is empathic concern. Here, while the subject feels the emotions of the object, the subject is also aware that the object is the source of its emotions and can appreciate and comprehend the other’s situation (Preston & de Waal, 2002). This new distinction between internally and externally generated emotions opens the door for more sophisticated empathic emotions – emotions such as guilt, compassion, sorrow, but also spitefulness, resentment and envy. Often, empathic concern evokes an other-oriented, altruistic motivation to alleviate the other’s distress (Batson & Shaw, 1991). The last stage of empathy is empathic perspective taking. The observer takes the target’s perspective, takes their subjective situation and mental state into account, and uses this information to interpret the emotions they intuitively sensed through affect sharing.

To illustrate, picture a mother who hears her baby cry. Initially feeling distressed herself; she quickly shifts perspectives and consequently feels compassion with the baby and a strong motivation to alleviate the baby’s distress. She, then, assesses the baby’s situation, taking into account what she knows about its preferences, goals, and behavioral patterns, to infer what caused the distress and what can reduce it. Without the initial vicarious distress, however, the mother would lack the basis for all subsequent steps in her progress to helping - she would lack the emotions necessary to fuel the motivation to help. Similarly, research on psychopaths shows that, even with their higher order empathic perspective taking functions intact, without the ability to feel with other’s pain, through affect sharing, these individuals are able to severely harm and
sometimes kill others (Blair, 2008) – affect sharing through motor resonance is important for all subsequent stages of empathy.

Moreover, recent evidence indicates that motor resonance is linked to empathy—the more people show evidence of neural simulation to others’ actions and emotions, the higher their levels of trait empathy (Hooker, Verosky, Germine, Knight, & D’Esposito, 2010) and the better they perform on tasks that are contingent on emotional empathy (Pineda & Hecht, 2009).

3.2 Empathy and its Limits

Although motor resonance and affect sharing may be unconscious, there is growing evidence that they are subject to top-down influences. One such influence is group-affiliation, with research suggesting an “empathy-gap” whereby people are less likely to catch and match the emotions of the outgroup than of the ingroup. For example, people are less likely to help outgroup than ingroup members in need (Kunstman & Plant, 2008; Saucier, Miller, & Doucet, 2005), and less likely to value the lives of outgroup members as much as ingroup members (Pratto & Glasford, 2008).

Evidence from the social neurosciences suggests that group affiliation similarly exerts a top-down influence on neural resonance of other’s suffering. A recent fMRI study, for example, found that people show more neural activation in pain circuits when observing the painful penetration of the face of ethnic ingroup members than of outgroup members (Xu et al., 2009) and when they see people in distressing and emotionally painful situations (Mathur, Harada, Lipke, & Chiao, 2010). Moreover, such differences in empathy-related neural activation predict costly helping behavior (Hein, Silani, Preuschoff, Batson, & Singer, 2010) and using transcranial magnetic simulation (TMS), Avenanti, Sirigu, & Aglioti (2010) found less corticospinal muscle
inhibition when participants observed ethnic outgroup members receiving painful stimuli than when observing the same thing happening to ingroup members.

Finally, as described in the previous chapter, I have provided evidence that motor resonance for actions is limited to the ingroup and is not available for the actions of outgroup members (Gutsell & Inzlicht, 2010). Rather than reflecting innate ingroup preferences, however, such ingroup biases may occur as a function of culturally-learned prejudice (Chiao & Mathur, 2010). For example, people high in social dominance orientation (Pratto, Sidanius, Stallworth, & Malle, 1994; Sidanius & Pratto, 2003), a personality trait that is strongly related to higher levels of prejudice, show less activation in neural areas for pain when they see people in painful situations (Chiao et al., 2009). In an intergroup context, high-prejudice people are especially likely to show diminished motor resonance with the outgroup, be that diminished motor cortex activity (Gutsell & Inzlicht, 2010) or reduced corticospinal inhibition (Avenanti et al., 2010). Furthermore, the reduction in motor resonance in these two studies was particularly acute for culturally-disliked outgroups, e.g., South Asians in Canada (Gutsell & Inzlicht, 2010) and Blacks in Italy (Avenanti et al., 2010). Together, these studies suggest that these brain effects are more a function of culture than innate preference.

The empathy gap may be part of a broader bias in perceptual processes whereby we are more generally less receptive to outgroup members, including their facial expression and emotions. People have greater difficulty recognizing outgroup members’ faces and interpreting their facial expressions and voices relative to the ingroup (Elfenbein & Ambady, 2002b; Sporer, 2001). In addition, there seem to be differences in not only how sensitive people are to the emotional expressions of outgroup members, but also in how they react to these emotions. For example, fear and happiness expressed by outgroup faces elicit the opposite emotional reaction
in the observer (Weisbuch & Ambady, 2008). Moreover, people show greater amygdala response in response to fearful ingroup compared to outgroup faces (Chiao et al., 2009) – possibly because the amygdala is sensitive to motivational relevance (Cunningham, Bavel, & Johnsen, 2008) and fear in ingroup members is more likely to signal danger to one’s self than fear in outgroup members. Noticing the fear of someone from one’s own ingroup, therefore, becomes relevant to one’s own safety. In short, the emotions expressed by ingroups and outgroups may be perceived and reacted to differently.

3.3 Overview

All told, social biases act as top-down influences that interfere with motor resonance when it comes to outgroup targets, I suggest that people are less able to catch and match the emotions of other people when those other people come from an outgroup. To my knowledge no one has directly examined the sharing of emotions with the ingroup vs. outgroup on a neural level. Previous studies have focused on basic motor and sensory processes such as motor activity or the sensation of pain (Avenanti et al., 2010; Gutsell & Inzlicht, 2010; Mathur et al., 2010; Xu et al., 2009), but empathy also involves the sharing of basic emotional and motivational states (Hatfield, Cacioppo, & Rapson, 1994; Levenson & Ruef, 1992). It is unclear from past research, therefore, if there is an empathy gap in the actual sharing of emotions. To further investigate this specific issue, researchers need to measure emotional processes more directly. In the current study, I measure prefrontal alpha asymmetry as an index of emotional and motivational states (Davidson & Tomarken, 1989; Harmon-Jones, 2003) to reveal possible ingroup biases in the extent to which people intuitively catch the emotions of other people.
We used EEG to measure the relative activation of the right and left prefrontal cortices; prefrontal cortical areas being essential for processing of reward and punishment related information (Davidson, 2004). Studies have consistently associated activity in the left prefrontal cortex with the expression and experience of approach-related motivational and affective states such as happiness, but also anger. In contrast, activation of the right prefrontal cortex has been related to the expression and experience of withdrawal-related motivational and affective states such as fear or sadness (Davidson, 2004; Harmon-Jones, Gable, & Peterson, 2010). These differences in functionality have often been measured using relative EEG activity in the alpha band (8-13 Hz) in electrodes over left and right prefrontal cortex (for a review, see Davidson, 1995). For instance, higher activation of right prefrontal cortex, as indicated by relatively lower alpha at right prefrontal electrode sites, is associated with, depression (Allen, Iacono, Depue, & Arbisi, 1993), a general trait-like negative emotional style (Wheeler, Davidson, & Tomarken, 2007), and with negative emotional responses to films (Davidson, Ekman, Saron, Senulis, & Friesen, 1990). In contrast, higher activation of left prefrontal cortex is associated with approach related positive affect (Gable & Harmon-Jones, 2008) and approach related anger (Harmon-Jones & Sigelman, 2001). Importantly, the prefrontal cortex is involved in the experience and expression of emotions, but not in the perception of emotions (Davidson, 2004). Hence, measures of prefrontal alpha asymmetry during observation of an object-other provide a measure of vicarious emotions free from confounds due to the mere perceptions of emotions.

I predicted that participants would show stronger right prefrontal alpha asymmetry, indicating negative, withdrawal related emotions while experiencing sadness and that they would show similar right prefrontal alpha asymmetry when passively observing ingroup members nonverbally expressing sadness. Reflecting an ingroup bias, I expected no such vicarious right prefrontal alpha asymmetry during the observation of outgroup members experiencing sadness. I
further predicted that this lack of vicarious emotion when passively observing the outgroup would be associated with participants’ level of prejudice: the more prejudiced people are, they less they will catch the outgroup’s emotions.

3.4 Method

3.4.1 Participants

Our original sample consisted of 30 right handed university students. Participants were recruited from an introductory psychology course at the University of Toronto Scarborough, and participated in the study for course credit. Two participants were excluded from my original sample due to a technical malfunction of the EEG system and another two were excluded because they self-identified as Black and mixed-race. Consequently, my final sample consisted of 26 participants, 10 males and 16 females, from various non-Black ethnic backgrounds (8 White, 6 East Asian, and 12 South Asian). The participants ranged in age from 18 to 23 Years ($M= 18.46, SD= 3.81$).

3.4.2 Procedure

Participants were told that the study’s purpose was to investigate the neural underpinnings of emotions. Participants read and signed an informed consent sheet and were then fitted with and electrode cap for EEG recording. EEG was recorded while participants watched a set of videos. The videos showed a variety of ingroup and outgroup members expressing sadness. At the end of each video set, participants completed an emotion induction task during which they were led to feel sadness by vividly remembering past sad events in their lives. To assess how individual differences in prejudice and in the ability to empathize with
others are related to differences in the vicarious experience of emotional states, I then had participants complete several trait measures of prejudice and empathy.

3.4.3 Materials

3.4.3.1 Symbolic racism scale.

Participants completed the symbolic racism scale (Henry & Sears, 2002) during a mass testing session in an introductory psychology course at the beginning of the term. The symbolic racism scale is a measure of modern racism – a subtle form of racism that obscures racist feelings with abstract values, such as justice and order.

3.4.3.2 Video manipulation.

The study had a one way within subject design with three conditions (self condition, ingroup condition, and outgroup condition). Figure 4 graphically illustrates the design. For the purpose of my study I defined ingroup as people who shared the participant’s ethnic identity, and outgroup as people who did not. Videos of ingroup and outgroup members (White, Black, South Asian, and East Asian) expressing sadness served as the independent variable for the randomly presented outgroup and ingroup conditions, and this was followed by the self condition. The videos depicted the actors sitting at a table in front of a white wall expressing sadness. In the outgroup condition the participant saw four different actors from each ethnic outgroup. For example, a white participant would see four different black actors for 20 seconds each, followed by 4 different East Asian actors, and 4 different South Asian actors. In the ingroup condition participants saw four different ingroup members, each for 20 seconds, expressing sadness.
To control for differences besides the ethnicity of the individual actors, I asked a separate pilot sample of 9 people to rate the videos. Specifically, after viewing each video, the raters used a 5-point scale to indicate the extent to which they thought the videoed individual (1) felt sad, (2) felt positive, (3) felt negative, (4) experienced a strong emotion, (5) experienced an arousing emotion, (6) was likable, and (7) was attractive. Raters further indicated (8) the overall technical quality of the video, and (9) the amount of empathy they felt for the actor. Results revealed no significant differences between ethnic groups on any of these variables, all ps > .16, ns, suggesting that the actors from each ethnic group were viewed similarly, at least at an explicit level.

To ensure that participants attended the videos throughout the whole session, they performed a control task during the ingroup and outgroup conditions. For this task, the videos stopped between 2 and 5 times and the screen turned black for 1 second during each condition. Participants were asked to count how many times the black screen appeared and to indicate the
number of such pauses at the end of the condition. Participants reported the correct number of black screens in 83% of all cases indicating that they attended to the videos.

All ingroup and outgroup videos were presented in a random order, thus the ingroup condition could appear in any position in the set of videos. The actors in the videos were male students of the University of Toronto and therefore were approximately the same age, but not always the same sex as the participants. Each actor was displayed for twenty seconds. Consequently I obtained 80 seconds of EEG data during the ingroup conditions and 240 seconds during the outgroup conditions - 80 seconds during each of the three different ethnic outgroups.

At the end of the video set, the participants were asked to experience the emotion of sadness themselves (self condition). To facilitate the experience of sadness, participants completed an emotion induction exercise, which consisted of a series of instructions aimed to elicit vivid memories of past sad events. Participants saw the following instruction: “Please think about a situation in your past, which made you feel very sad. Imagine the situation as vividly as you can.” After completion of the exercise participants continued experiencing the emotion for 80 seconds while they looked at a blank computer screen.

3.4.3.3 Empathy Quotient.

In order to assess the trait like ability to empathize with others, I had participants complete the empathy quotient (Baron-Cohen & Wheelwright, 2004). The empathy quotient is a 60 item forced choice self report scale that taps into both cognitive and emotional aspects of empathy.
3.4.3.4 Reading the mind in the eyes test.

I administered a second measure related to empathy – reading the mind in the eyes test (Baron-cohen, Wheelwright, Hill, Raste, & Plumb, 2001) – a measure of mindreading and social sensitivity. Specifically, in this test participants are presented with a series of 25 photographs of the eye-region of different faces. For each photograph they have to select one of four words that best describes what the person in the photograph is thinking or feeling.

3.4.4 EEG Data Acquisition and Processing

To measure prefrontal alpha asymmetries, I recorded the EEG from 32 Ag/AgCl sintered electrodes embedded in a stretch-lycra cap. Recordings were collected from the 32 electrode sites according to the 10-20 system with a band pass filter at 0.1 - 100Hz and a notch filter at 60 Hz. The EEG was digitized at 512 Hz using ASA acquisition hardware (Advanced Neuro Technology, Enschede, the Netherlands) with an average earlobe reference. Vertical eye movements (VEOG) were monitored using a supra-to sub-orbital bipolar montage and the continuous EEG recordings were corrected off-line for eye-blinks using the VEOG channel and the Second Order Blind Identification (SOBI) procedure, which is a signal processing method for isolating and removing ocular artifacts (Tang et al., 2005). During recording, the impedances were kept below 5 Kohm to ensure a clear and strong EEG signal. Continuous artefact-free epochs of 2.0s from each interval were extracted through a Hamming window and overlapped by 75% to minimize data loss. As said above, I recorded 80 seconds of data for the observation of each ethnic group. To avoid habituation, however, I calculated power only for the first 10 seconds of each actor, resulting in 40 seconds of data for each ethnic group. For the same reason, I only included the first 10 seconds of EEG data acquired during the self condition. Power was calculated via fast Fourier transform. Power values (in µV²) were averaged across epochs within
each interval. Total power within the alpha band (8-13Hz), an inverse indication of cortical activity, was logarithmically transformed and asymmetry scores were calculated as right-site minus homologous left-site alpha power for lateral prefrontal sites (F8-F7), which is consistent with how prefrontal asymmetry is typically calculated (Harmon-Jones, 2006). Higher scores indicate relatively greater left-than-right cortical activation indicating more approach motivation and less sadness/withdrawal.

3.5 Results

Results confirmed my hypotheses suggesting an ingroup bias in emotional sharing (see Fig. 5). I created index scores of relative alpha activity for each condition (log right alpha activity at F8– log left alpha activity at F7); such that more negative scores reflect greater withdrawal and negative emotionality. A within subject ANOVA over the three conditions (self, ingroup, and outgroup) did not reveal a significant main effect for condition $F(2, 23) = 3.90; p = \text{ns}$. However, although the difference in alpha asymmetry scores for the ingroup and the outgroup condition was not significant $t(24) = -.99; p = \text{ns}$, a significant linear trend indicated that alpha asymmetry was highest during personal experience of sadness, followed by the observation of the ingroup, and then by the observation of the outgroup, $F(1, 23) = 4.37, p < .05$. Participants’ alpha asymmetry scores when personally experiencing sadness ($M = -.08, SD = .17$) and when observing ingroup members (ideographically chosen) experiencing sadness ($M = -.05, SD = .15$) did not differ from one another, $t(24) = 1.28, p > .20$. This suggests a similarity in emotional/motivational states when personally experiencing/remembering sadness and when observing the ingroup experiencing sadness. In contrast, participants did not show such prefrontal alpha asymmetry when passively observing outgroup members: Participants had significantly more alpha asymmetry when personally experiencing sadness than when observing
an outgroup member experiencing sadness, \((M = -.03, SD = .14)\), \(t(24) = 2.09, p < .05\). These effects were specific to frontal sites such that alpha asymmetry scores at posterior lateral sites for all the conditions were positive (all \(Ms > .05\)), did not differ from one another (all \(ps > .43\)), and did not show a significant linear trend \(F(1, 23) = .64; p = ns\). These data suggest that observing a sad person from one’s own group elicits about the same amount of sadness as feeling sad oneself; outgroup members, in contrast, elicit significantly less sadness. These findings suggest an ingroup bias in emotional sharing.

![Alpha asymmetry scores](image)

**Figure 5:** Alpha asymmetry scores (log right alpha activity – log left alpha activity) during the experience and observation of sadness as a function of group membership. More negative scores indicate avoidant, negative affect.
When I break down the omnibus outgroup to specific ethnicities, I did not find any differences between subgroups. For example, White participants tended to have similar levels of brain activity when passively viewing Blacks, South Asians, or East Asians. Once in the outgroup, in other words, participants stopped differentiating between ethnicities (cf. Gutsell & Inzlicht, 2010).

Our second prediction regarding the role of prejudice gained limited support. The results are depicted in figures 6 and Table 1. Prejudice was only marginally associated with prefrontal asymmetry scores in response to outgroup members: The higher participants scored on the modern racism scale, the higher their asymmetry score, that is the less relative right prefrontal activation they showed, \( r (24) = .37, p = .07 \). This suggests that the more prejudiced people were, the less they might have vicariously felt an avoidant motivational state when observing outgroup member in distress. The more prejudiced, the less they caught outgroup members’ emotions. Another study with more power is needed to confirm these marginally significant results. In contrast, the correlation between prejudice and prefrontal asymmetry scores in response to ingroup members was not significant, \( r (24) = .32, p = .12 \). However, it is important to note that these two correlations are not significantly different from one another. So while prejudiced people do not seem to vicariously share emotive states with outgroups, they may show a (non-significant) tendency to not share it with ingroup members either. This may suggest that biased attitudes toward outgroups may reflect egocentric biases more generally. For example, research on the prejudiced personality suggests that people who score high on prejudice are less likely to be agreeable (Graziano, Bruce, Sheese, & Tobin, 2007). And agreeableness is associated with prosocial behavior (Graziano et al., 2007) and empathy (Nettle, 2007). Someone who is prejudiced, therefore, may be less agreeable in general and show a lack of empathy towards others in general.
Figure 6: Symbolic racism scores as a function of prefrontal alpha asymmetry scores in the outgroup condition.

<table>
<thead>
<tr>
<th>Alpha-asymmetry score</th>
<th>Symbolic Racism score</th>
<th>Empathy Quotient</th>
<th>Reading the mind in the eyes test score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingroup</td>
<td>$r = .32$</td>
<td>$r = -.33$</td>
<td>$r = .26$</td>
</tr>
<tr>
<td></td>
<td>$p = .12$</td>
<td>$p = .11$</td>
<td>$p = .22$</td>
</tr>
<tr>
<td>Outgroup</td>
<td>$r = .37$</td>
<td>$r = -.27$</td>
<td>$r = .35$</td>
</tr>
<tr>
<td></td>
<td>$p = .07$</td>
<td>$p = .20$</td>
<td>$p = .10$</td>
</tr>
</tbody>
</table>

Note: Higher alpha asymmetry denotes less vicarious sharing of sadness.

Interestingly, and inconsistent with my predictions, people’s general tendency and ability to empathize with others and to read their emotions did not significantly predict alpha asymmetry.
in response to ingroup or outgroup members. That being said, although the effects were not significant nor do we observe a trend, the pattern of the results suggest that future studies with more power might find a relation to empathy such that the higher people are in empathy, as assessed by the empathy quotient (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004), the higher their asymmetry scores to both ingroup and outgroup. Please see Table 1 for a more detailed depiction of these results.

3.6 Discussion

Taken together, my research provides direct evidence that people are less likely to show prefrontal right alpha asymmetry when observing sad outgroup others. I take this as evidence that people generally do not vicariously feel the emotional and motivational states of those they categorize as outgroup members. Moreover, the extent of vicarious right alpha asymmetry in response to sad outgroup members is associated with level of prejudice. In other words, the more prejudiced people are, the less likely they will intuitively catch the emotive states of outgroup members. This bias in affective sharing could contribute to an empathy-gap, impairing the experience of empathy for outgroups, which is a capacity that underlies and facilitates social understanding and cooperation and fosters helping, morality, altruism, and justice (Batson et al., 1997; Cialdini, Brown, Lewis, Luce, & Neuberg, 1997). Thus, when people fail to share the emotional and motivational states of outgroup members they might not be as responsive to outgroup member’s needs and might be less likely to help or even to understand that support is needed. This could be particularly true for people high in prejudice.

It is important to note that my findings do not indicate any causal direction between the lack of empathy towards outgroups and prejudice. While it is possible that a lack of empathy can
contribute to prejudice, it is just as likely that prejudice contributes to a lack of empathy. It is possible that both mechanisms are at work, creating a cycle in which people initially empathize less with outgroups, which makes them a likely target for prejudice, which then further restricts empathy towards the disliked group. The exact nature of the relationship is difficult to determine and should be addressed by future research.

Finally it is important to stress that, although I suspect that the ease with which people can empathize with the ingroup may have been biologically hardwired by evolutionary processes, I am not suggesting that people are more or less likely to include or exclude specific ethnic groups. Indeed, the gap in motor resonance may be specific to culturally disliked groups that change from one society to the next (e.g. Gutsell & Inzlicht, 2010). Instead, the specific coalitional alliances that populate our ingroup category are likely arbitrary, and can in fact be changed very easily (Turner et al., 1979). Recent research shows that despite a lifetime's experience of race as a predictor of social alliance, minimal exposure to alternate coalitional possibilities is enough to deflate the tendency to categorize by race (Cosmides, Tooby, & Kurzban, 2003; Van Bavel & Cunningham, 2009).

Hence, even if we are less likely to resonate with the emotions and actions of the outgroup, these effects may be temporary and can be erased when we foster empathy toward the outgroup, or better yet, include a greater number of people into our ingroup and thereby increasing their motivational relevance. One means to achieve this goal might be cognitive perspective taking. Taking the perspective of an outgroup member has been shown to reduce prejudice towards the outgroup (Batson et al., 1997) and this reduction is mediated by an increase in perceived self-other overlap (Galinsky & Moskowitz, 2000). By fostering a feeling of connectedness, perspective taking offers a way to overcome biases in motor resonance and
thereby allows an intuitive understanding between people whether they share group membership or not. In the following chapter I describe a study that looks at the potential of perspective-taking in reducing group biases in motor resonance.
4 Perspective taking reduces group biases in motor resonance

People say that to gain a true understanding of another, one needs to put oneself into another’s shoes and try to see the world through their eyes. The assumption here is that understanding comes from using one’s own references and one’s own body to simulate the experiences of the other. In recent years, neuroscience has supported these folk psychology notions of how we understand each other: the mere perception of other’s actions (Oberman, Ramachandran, & Pineda, 2008), facial expressions (Carr et al., 2003), and pain (Singer et al., 2004) produces the same type of neural activity that would occur if one were to actually engage in action, express emotions, or feel pain. Such neural resonance might be associated with more emotional empathy (Pineda & Hecht, 2009) and potentially facilitates an intuitive understanding of the other’s actions, intentions and emotions (Fadiga et al., 1995).

Neural resonance, however, can be more or less effective depending on the target. For example, people only resonate with the pain of those they like (Singer et al., 2006). Neural resonance can also be biased in systematic ways, excluding whole groups of social targets. For instance research participants show activation in neural pain networks only when they see members of their own ethnic group in pain, but not ethnic outgroups (Xu et al., 2009). Similarly, participants show activation in sensory motor areas only when observing people of the same, but not different ethnicities (Avenanti et al., 2010; Gutsell & Inzlicht, 2010).
Thus, the kind of social target matters. Whether we resonate with others, however, might also depend on our state of mind. Specific mindsets might override prepotent tendencies. Here, I ask how the perceiver’s mindset affects motor resonance and whether being in an empathic mindset could increase motor resonance even for targets, such as ethnic outgroup members, who we would otherwise not resonate with.

4.1 Limiting and Facilitating Factors for Motor Resonance

Motor resonance is not as automatic and inevitable as one might think; we do not resonate with just any action, with just any target, at just any time. Whether someone resonates with somebody else depends on many variables, some related to the kind of action, some related to the target, and some related to the observer. For example, research participants show less motor resonance in non-interactive situations than interactive situations (Oberman et al., 2008), in situations that require complementary responses rather than non-complementary ones (Sartori, Cavallo, Bucchioni, & Castiello, 2011), and those that involve unfamiliar rather than familiar actions (Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005).

Characteristics of the target, such as cultural background and ethnicity also modulate motor resonance. As described in chapter two I found less motor resonance in response to ethnic outgroup members than ethnic ingroup members performing a simple action (Gutsell & Inzlicht, 2010). Moreover, Molnar-Szakacs, Wu, Robles and Iacoboni (2007) found that whether participants showed corticospinal muscle inhibition in response to culturally specific gestures depended on the cultural background of the target person.

Prejudice, a perceiver variable, also influences motor resonance. People high in prejudice are especially likely to show diminished motor resonance with the outgroup, be that
diminished motor cortex activity (Gutsell & Inzlicht, 2010) or reduced corticospinal inhibition (Avenanti et al., 2010). Thus, the perceivers’ chronic biases and assumptions shape how much and with whom they resonate. Hence, changing the perceiver’s mindset might be a powerful tool to influence the amount of motor resonance. In this study, I examine how experimental changes to the perceiver’s mindset can influence motor resonance. Specifically, I ask if having people take the perspective of someone else could enhance motor resonance.

4.2 Cognitive Perspective Taking

Cognitive perspective taking refers to the active contemplation of others’ psychological experiences. It has long been considered to predict greater empathy. For example, perspective taking facilitates altruistic behavior (Batson et al., 1997) and cooperation (Batson & Moran, 1999). In addition to these more general benefits of perspective taking, it can be helpful specifically in an intergroup context (Batson et al., 1997; Dovidio et al., 2004; Galinsky & Ku, 2004). Perspective taking improves evaluations of specific members of the outgroup and of the outgroup more generally (Dovidio et al., 2004; Galinsky & Ku, 2004). For example, nurses who take the perspective of Black chronic pain patients show less racial bias in decisions for pain treatment than those who do not take the patient’s perspective (Drwecki, Moore, Ward, & Prkachin, 2011).

Taken together, cognitive perspective taking can improve interpersonal rapport and facilitate altruistic behavior towards individuals who would otherwise be unlikely targets of empathy. Moreover, the positive effects of perspective taking can generalize beyond the interpersonal domain to encompass intergroup situations as well—taking the perspective of one outgroup individual can affect how one perceives and treats other outgroup members in
situations outside of the perspective taking context and at a later time. Given all the benefits of perspective taking, a perspective taking mindset could be a powerful tool to decrease intergroup biases, including biases in motor resonance.

4.3 Overview

Some research suggests that perspective taking could potentially have an effect on motor resonance. People who tend to take the perspective of others also have a tendency to imitate others (Chartrand & Bargh, 1999). Perspective taking also increases cognitive co-representation of others’ behavior. In one study, participants, after having taken the perspective of an outgroup member, showed less interference in a joint simon task – a measure of co-representation of another’s actions (Müller et al., 2011). Moreover, directly measuring brain activity over sensory motor areas using EEG, Woodruff and Bilyk (2011) showed that people who score high on a self-report trait measure of perspective taking, show stronger neural activity in the motor cortex while observing others performing actions.

Here, I directly investigate the effects of a perspective-taking mindset on motor resonance in an intergroup context. I hypothesize that people in a perspective taking mindset will resonate even with members of a social outgroup. In contrast, I hypothesize that putting people in an objective mindset (a detached, uninvolved approach when thinking about others’ experiences) will lead them to resonate less with others, even others belonging to the ingroup. Thus, I expected perspective taking to reduce group biases in motor resonance.

To test this hypothesis I measured EEG oscillations over sensory motor areas in the mu-frequency range while participants watched videos of ethnic ingroup and ethnic outgroup members performing a simple action.
4.4 Methods

4.4.1 Participants

36 self-identified White undergraduate students enrolled in an introductory psychology course at the University of Toronto Scarborough participated in the study for course credit. Two participants were excluded because they did not follow the instructions and four were excluded because of missing data due to experimenter error or equipment failure. This resulted in a total of 30 participants (16 female; average age = 20.10, $SD = 2.22$) included in my final sample. I used a 2 (Mindset: perspective taking vs. objective) x 2 (Group: ingroup vs. outgroup) mixed design with the last factor repeated. The ingroup was defined as participant’s ethnic ingroup (White) and the outgroup as people of a different and often marginalized ethnic group (Black).

4.4.2 Procedure

Participants arrived in the laboratory one at a time and provided informed consent. After fitting each participant with an electrode cap, I recorded 30 seconds of baseline EEG activity. Next, participants were randomly assigned to one of the two mindset conditions. All participants saw the same picture of a Black male university student and were asked to write a short story describing a day in life of this student. Those in the perspective taking condition were asked to take the perspective of the student while writing. Those in the control condition were asked to remain as objective as possible depending while writing the story. After completion of the story, participants saw a series of videos showing a variety of ingroup and outgroup members performing a simple action while I recorded their EEG.
4.4.3 Materials

4.4.3.1 Mindset manipulation.

To manipulate a perspective taking mindset versus an objective mindset I showed participants a picture of a young Black university student. The student was shown sitting on a couch, holding an open book, while gazing into the camera with a smile. Participants were asked to write a short story about a day in his life either taking his perspective, or remaining objective. Specifically, in the perspective taking condition participants were asked to: “Take the perspective of the individual in the photograph and imagine a day in the life of this individual as if you were that person, looking at the world through his eyes and walking through the world in his shoes.” and to write the story in first person. In contrast, participants in the objective mindset condition read the following instructions:” Try to be as objective as possible when imagining what is happening to this individual and what his day is like. Don’t get caught up in imagining what this individual might think or how he might feel.” and they were asked to write the story in third person.

4.4.3.2 Video stimuli.

While I recorded their EEG, participants saw a series of videos showing young university-aged men of African-Canadian and European-Canadian origin repeatedly drinking a sip of water from a glass and putting it back down. The videos were taken from a set of videos previously used in a study described here in chapter 2 and in Gutsell and Inzlicht (2010), though participants in the current study did only see a subset of the videos presented in the previous study. Specifically, participants saw two blocks of videos each containing three 10second video-clips of 3 different White actors or 3 different Black actors, respectively. Both the order of the video blocks and the order of the videos within the blocks were randomized. Following the
videos, I asked participants to perform the same action themselves. Participants received a glass of water and, repeatedly drank a small sip and put the glass back in place for 30 seconds.

4.4.4 Electrophysiological Recording and Processing

To measure mu-rhythm, I recorded the EEG from 32 Ag/AgCl sintered electrodes embedded in a stretch-lycra cap. Recording procedure and data processing were identical to the procedures used in Gutsell and Inzlicht (2010) described in chapter 2 of the current dissertation. I performed fast Fourier transformation and calculated power in the 8–13 Hz band for 30 seconds for each ethnic group and 30 seconds for self-action and for baseline. I then averaged the spectral data over the three outgroups.

4.5 Results

To control for differences in baseline mu power, I calculated log-ratio scores of mu power during the observation of action and during action (log mu oscillations during action observation/ log mu oscillations during baseline) for all conditions. More negative scores indicate a stronger suppression of the mu-rhythm and, hence, more cortical activity. Since the resulting mu-suppression scores serve as an indicator of activation of neural sensory motor areas, I expected strong mu-suppression during the self-action condition in the left hemisphere contralateral to movement of the right dominant hand. Thus, although I calculated mu-suppression scores for all electrodes I performed statistical analysis only for electrode C3 located over the contralateral, left primary motor area.

As predicted, mu-suppression scores during the self-action condition ($M=-.40, SD=.67$) were significantly different from zero $t (29) = -3.40; p < .05, d = .60$, indicating that sensory
motor areas were active while participants performed the action themselves. Moreover, reflecting that neural activation during actual actions is not influenced by the kind of cognitive mindset, I found no significant difference in mu-suppression scores $t (28) = .36, ns$, during the self-action between participants in the objective ($M = -44, SD = .85$) and the perspective mindset condition ($M = -.36, SD = .41$).

In contrast, I expected mindset to influence mu-suppression during the observation conditions. Previous research has shown that by default, participants show mu-suppression for ethnic ingroup members, but not for the ethnic outgroup (Gutsell & Inzlicht, 2010). To test whether adopting a perspective taking mindset could alleviate these group biases in mu-suppression, I first conducted a one sample t-test for the objective and the perspective taking mindset separately. Figure 7 illustrates that that adopting a perspective taking mindset facilitates mu-suppression: participants in a perspective taking mindset showed mu-suppression significantly different from zero both when observing ingroup members ($M = -.11, SD = .20; t (15) = -2.16; p < .05, d = .55$) and when observing ethnic outgroup members ($M = -.13, SD = .23; t (15) = -2.20; p < .05, d = .57$). These findings suggest that participants in the perspective taking mindset showed mu-suppression not only for the ingroup, but also for the outgroup. In contrast, mu-suppression scores for participants who had adopted an objective mindset were not significantly different from zero, neither for the ingroup ($M = -.11, SD = .61; t (13) = -.68, ns, d = .18$) nor for the outgroup ($M = 0.07, SD = .50; t (13) = .49, ns, d = .14$) suggesting that an objective mindset hampers mu-suppression for both the ingroup and the outgroup.

Taken together, these findings suggest that a perspective taking mindset affects people’s general tendency to resonate with others: When in a perspective taking mindset, people show
mu-suppression indicative of motor resonance, and when in an objective taking mindset, they do not$^2$.  

**Figure 7:** EEG mu-suppression at left central scalp location (C3) during the observation of ingroup and outgroup members for participants in a perspective taking mindset and for participants in an objective mindset. Error bars represent ±1 standard error. Negative numbers denote more mu-suppression (i.e. more neural activity) at C3.

To test whether the ingroup and the outgroup condition where differentially affected by the mindset manipulation, I conducted a 2 (mindset: perspective taking vs. objective) X 2

$^2$ Please note, however, that we have to be careful when interpreting the findings for the objective mindset condition. Because we had to exclude several participants from analysis our sample size is relatively small (n = 15). Based on the effect size obtained for mu-suppression for the ingroup in the objective mindset condition, with this sample size we only have a power of .48 to find the effect. In order to have reasonable power (.80 or higher) we’d need at least 28 participants in the objective mindset condition. Nonetheless, given that we consistently do not find mu-suppression for the outgroup in neutral conditions (Gutsell & Inzlicht, 2010; Gutsell & Inzlicht, in preparation – also see chapter 5 in this document for these findings), we are relatively confident that we would find the obtained null effect would also hold in a higher power design.
mixed model ANOVA with the last factor repeated. This analysis revealed no significant main effect for group $F(1, 28) = 2.36, p = ns$, but a marginally significant interaction, $F(1, 28) = 3.84, p = .06$. Additional analyses confirmed our hypothesis that having people adopt an empathic mindset reduces group biases in motor resonance. Participants in the objective mindset condition showed significantly more mu-suppression for the ingroup ($M = -.11, SD = .61$) than for the outgroup ($M = .07, SD = .50$), $F(1, 28) = 5.73; p < .05, d = .62$. In contrast, participants in a perspective taking mindset do not show such group distinction: Mu-suppression for the ingroup ($M = -.11, SD = .20$) and the outgroup ($M = -.13, SD = .23$) did not differ, $F(1, 28) = .10, p = ns, d = .08$. These findings suggest that when in a perspective taking mindset, people show equal amounts of mu-suppression indicative of motor resonance in response to others regardless of the target’s group membership and, thus, no longer show an ingroup bias in motor resonance. At the same time, adopting an objective mindset makes it unlikely that people will resonate with others in general, and even less so when the other is a member of an ethnic outgroup.

### 4.6 Discussion

Previous research indicates that people do not resonate with others if they are not part of their own ethnic group (Avenanti et al., 2010; Gutsell & Inzlicht, 2010). Using an electrophysiological indicator of motor resonance, I investigated how a perspective taking mindset influences the amount of motor resonance with others in general and with the outgroup in particular. I found that after participants took the perspective of an outgroup member, they showed a reduction in rhythmic mu-oscillations over sensory motor cortex when later observing other outgroup members performing actions. Thus, when people are in a perspective taking mindset, they resonate with the actions of outgroup members – something they do not usually do.
Moreover, these same participants did not show group biases in motor resonance; instead they displayed equal levels of mu-suppression in response to ingroup and outgroup members. In contrast, participants, who adopted an objective mindset failed to show motor resonance in response to outgroup members. Instead, they showed a group bias in motor resonance; such that they resonated significantly less with outgroup members than with ingroup members.

Therefore, putting people in a perspective taking mindset is an effective mean to reduce group biases in motor resonance. Motor resonance most likely helps people to gain an intuitive understanding of others’ actions and intentions (Fogassi et al., 2005) and might even be involved in basic empathic processes such as emotional contagion (Pineda & Hecht, 2009). Hence, group biases in motor resonance might ultimately translate to misunderstandings and impaired social rapport, empathy, and social coordination. Perspective taking has been shown to successfully reduce prejudice (Batson et al., 1997; Galinsky & Ku, 2004), to build social bonds, and to increase empathy and helping (Batson et al., 1997). Alleviating group biases in motor resonance might yet be another important benefit.

4.6.1 The Objective Mindset

In past research, the objective mindset manipulation I used here was assumed to be a neutral state and thereby served as a control condition (e.g. Galinsky, Wang, & Ku, 2008; Todd, Bodenhausen, Richeson, & Galinsky, 2011). I wonder, however, if this is a fair assumption given that in the present study, being in an objective mindset does not seem to be a neutral state at all. In a neutral state, research participants tend to resonate with social ingroup members (Avenanti et al., 2010; Gutsell & Inzlicht, 2010) and neutral targets (Oberman et al., 2008), but participants in the objective mindset of the current study failed to show significant mu-suppression to
anyone. My findings, therefore, suggest that adopting an objective mindset decreases motor resonance in general, not only for the outgroup.

We often stress the importance of staying objective, especially for certain professions. Judges, doctors, scientists all strive for objectivity, but sometimes the drawbacks of an objective mindset might offset the benefits. If a judge is blind to the subtle nuances of the witness’ facial expressions and body language, she might miss important information. If the doctor fails to intuitively catch and match his patient’s inner states he might have a harder time connecting with and diagnosing them. Indeed, more empathic medical students perform better on standard measures of medical competence, and their patients are more satisfied with their treatment (Blatt, LeLacheur, Galinsky, Simmens, & Greenberg, 2010). At the same time, being objective can be self-protective. For example, empathy and emotional contagion have been related to depression and fatigue in health care service personnel (Miller, Stiff, & Ellis, 1988). Thus, the consequences of adopting an objective mindset, both pro and con, should be further explored in future research.

4.6.2 Perspective Taking

Being in a perspective taking mindset has been shown to improve social interactions (Todd et al., 2011). Research participants who had previously completed the perspective taking mindset manipulation utilized in the current study, later liked an outgroup interaction partner better, displayed more friendly nonverbal behavior, and were judged as being more pleasant interaction partners than those who did not take a specific mindset or an objective mindset (Todd et al., 2011). The increase in motor resonance could potentially contribute to these positive intergroup interaction experiences. Mu-suppression is a very basic process that does not require conscious awareness or effort (Rizzolatti & Craighero, 2004), and thus does not draw cognitive
resources away from other important processes such as impression management and conversational skills. By facilitating social understanding, coordination, and rapport in an unobtrusive way, the increase of motor resonance could potentially facilitate smooth intergroup encounters. Future research should investigate such potential contributions by looking at motor resonance before and during intergroup interactions.

4.7 Conclusions

As a default, people tend not to resonate with the actions of outgroup members and consequently they might not intuitively grasp outgroup member’s actions, intentions and potentially even other inner states. The current research provides evidence for the utility of perspective taking as a strategy for combating this subtle consequence of racial bias. Adopting a perspective taking mindset has been shown to be conducive to smooth and pleasant intergroup interaction experiences. The findings reported here suggest a potential mechanism: When in a perspective taking mindset, people are more likely to resonate even with outgroup members, which potentially could provide them with a richer, more intuitive understanding of the other’s actions and intentions possibly leading to smoother and more positive intergroup interactions.

Perspective taking might be so efficient in reducing group biases in general and biases in motor resonance in particular because it reduces social categorization, thereby annulling the negative effect that categorizing someone as an outgroup member can have on motivational relevance for the observer. Increasing closeness to the target, however, is not the only possible approach to make a target motivationally relevant. If we truly take a functional approach to motor resonance, it does not seem sensible to think that people only resonate with those who they feel close to. Altruism and reciprocity are not the only reasons for why we need to
understand others’ goals and intentions, for why others’ behavior is motivationally relevant. Another reason for why a behavior might be relevant is that it poses a potential threat. Thus far, I only investigated motor resonance in response to neutral outgroup actions. The next chapter describes a study that investigated motor resonance for positive and threatening actions performed by ingroup versus outgroup members.
5 Threatening outgroup behavior is resonated with

When interacting with others, humans quickly and easily grasp the intentions, action tendencies, and inner states of their interaction partners. One mechanism through which this possibly could be achieved is through motor resonance, the activation of the observers own neural motor networks at the sight of the actions of another (e.g. Cheng, Tzeng, Decety, Imada, & Hsieh, 2006; Pineda & Hecht, 2009; Schippers & Keysers, 2011; Ulloa & Pineda, 2007; Woodruff, Martin, & Bilyk, 2011). By mapping the other’s actions and associated inner states with their own neural system, observers could potentially gain a more intuitive and personal understanding into the other’s experiences, which in turn could facilitate social coordination and smooth interactions. Motor resonance, however, is biased by prejudice and social group affiliations. For example, although people show neurophysiological EEG activity over sensory motor areas when observing ingroup members performing an action, they do not show motor resonance when looking at ethnic outgroup members performing an action (Gutsell & Inzlicht, 2010). Yet, from an evolutionary perspective, as well as in light of the challenges of modern, multicultural societies, it seems unlikely that people would never resonate with outgroup members. Depending on the situational context, the actions, intentions and experiences of an outgroup member could potentially be of equal, if not even more interest, than those of an ingroup member. Here I investigate motor resonance in just such a context: I ask whether motor resonance is increased for actions performed by a threatening outgroup members.
5.1 Motor resonance – a Prosocial Process?

Motor resonance is considered to underlie the understanding of actions and intentions (Erlhagen, Mukovskiy, & Bicho, 2006), which is in turn essential for interpersonal and social processes such as learning through observation, interpersonal coordination, communication, and empathy (Knoblich & Sebanz, 2006). As such, mirror neurons and motor resonance can appear as being somehow intrinsically prosocial. However, humans are not only empathic creatures. They also have the capacity to be Machiavellian, that is they use their ability to read others’ minds to predict their behavior and ultimately outsmart them (Byrne & Whiten, 1988; Carruthers, 2009; Dunbar, 2000). In essence, motor resonance is just a tool that gives us access to other’s inner states. What we do with this information can depend on many factors such as the specific situation, the perceivers’ personality and his or her relationship to the target (Hein & Singer, 2008). For example, we can understand the meaning and the nature of other’s sadness through resonating with their facial expression and by catching their distress through emotional contagion. Whether we will react with sympathy or schadenfreude or indifference depends on our relationship with them. Similarly, we might be interested in understanding others’ intentions because we could potentially learn from them or because they might aggress against us. In both cases motor resonance will help us to achieve our goal. Therefore, whether we resonate with other people should be determined by the motivational relevance of the target person. For example, a friend, or an ingroup member might be more relevant than a stranger or an outgroup member. Motor resonance should, however, also depend on how intrinsically relevant the actions are. A communicative gesture or a threatening action should be more relevant than a meaningless action.
As outlined before, the actions and expressions of social ingroup members seem to be intrinsically motivationally relevant. People tend to allocate their limited cognitive and perceptional resources towards others who, for one reason or another, are motivationally relevant to them (Ackerman et al., 2006). Moreover, these relevant others are most often members of the social ingroup. Consequently, intra group interactions are most important to us, and processing ingroup members’ inner states, goals and actions, most often takes priority (Ackerman et al., 2006), and, thus, by default motor resonance might be limited to the ingroup. Indeed, as described in the previous chapters, we showed that people do not show motor resonance in response to outgroup members actions (Gutsell & Inzlicht, 2010) and they do not tend to catch outgroup member’s affective and emotional states (Gutsell & Inzlicht, 2012).

In these previous studies, I only investigated motor resonance in response to neutral outgroup actions. Would people still show an ingroup bias in motor resonance, when the actions of outgroup members were more relevant to their own motivations, such as when the behavior in question would signal an attempt to affiliate or a threat? Threat in particular is highly motivationally relevant and could, thus be an effective mean to increase motor resonance.

5.2 A bias towards threat and negativity

A common finding is that humans have an attentional bias toward negative information in general, which likely is a consequence of our evolutionary history. According to this perspective, threat information is more important for survival than non-threat information, a bias towards negative and uncertain information is adaptive (e.g., Hirsh & Inzlicht, 2008; Rozin & Royzman, 2001). Individuals who are more vigilant for negative stimuli are more likely to avoid bad things
and would, thus, be more likely to pass along their genes (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001).

An example for the negativity bias is the fact that people focus more on and are motivated by potential losses than potential gains (Tversky & Kahneman, 1991). Similarly, negative stimuli have a greater impact on information processing than do positive stimuli (Taylor, 1991); they are also evaluated as being more extreme compared to equally intensive positive stimuli (Ito, Larsen, Smith, & Cacioppo, 1998). Moreover, people pay more attention towards negative information and are automatically drawn to it, and this happens within milliseconds as reflected in a negativity bias in early attentional event related potentials (Smith, Cacioppo, Larsen, & Chartrand, 2003).

The negativity bias also includes social stimuli. For example, Fiske (1980) found that people looked longer at photographs depicting negative than positive behaviors, presumably paying more attention to negative behavior when forming impressions. In addition to holding attention, negative social stimuli can also draw attention. For example, research participants were faster to pick a lone angry face out of a grit of happy faces than vice versa (Hansen & Hansen, 1988; Ohman, Lundqvist, & Esteves, 2001). Anger and threat might be particularly effective in an intergroup context, such that angry out-group members might be motivationally relevant because they pose a potential threat. In support of this hypothesis, Ackerman and colleagues (2006) found that people were able to remember outgroup faces better when those faces displayed an angry expression rather than a neutral one. Moreover, when participants cognitive capacities were limited, participants actually remembered angry outgroup faces better than angry ingroup faces, thus reversing the outgroup homogeneity effect that usually leads to worse memory of outgroup members (Ostrom & Sedikides, 1992).
5.3 Overview

Given the prevalence of the negativity bias and Ackerman and colleagues’ findings showing the effectiveness of anger and threat to increase the motivational relevance of outgroup members and to override ingroup biases in person perception, I aimed to test the effects that threat can have on motor resonance for outgroup members.

Here, I use suppression of EEG mu-oscillations as an index of motor resonance, in order to directly investigate whether threatening outgroup behavior is resonated with or not. I measured motor resonance, while participants watched videos of ethnic ingroup and ethnic outgroup members performing neutral, positive and threatening actions. I hypothesized that people would show mu-suppression in response to ingroup members independent of intent of the action, since ingroup members already motivationally relevant. Second, I hypothesize that people will not show mu-suppression in response to neutral outgroup behavior, replicating our previous findings (Gutsell & Inzlicht, 2010). Critically, I expect that, because of the negativity bias and the motivational relevance of threatening behavior, people will show mu-suppression in response to threatening outgroup behavior but not positive or neutral outgroup behavior. I do not have specific predictions about positive outgroup behavior. Positive behavior should be more motivationally relevant than neutral behavior, potentially increasing show mu-suppression in response to outgroup members. However, positive stimuli do not attract attention as much as negative stimuli do (See Peeters & Czapinski, 1990, for a review). Hence, it is also possible that positive behavior might not be motivationally relevant enough to affect show mu-suppression in response to outgroup members.
5.4 Method

5.4.1 Participants

33 self-identiﬁed European Canadian and East-Asian Canadian undergraduate students enrolled in an introductory psychology course at the University of Toronto Scarborough participated in the study for course credit. I had to exclude 3 participants due to missing data and experimenter error during EEG recording. Moreover, I excluded 7 participants because they did not show mu rhythm suppression during baseline recording. The ﬁnal sample consisted of 23 participants (12 female; 5 European Canadian; average age = 18.95, SD = 2.80). I used a 3 (Action intent: neutral vs. afﬁliative vs. threatening) x 3 (Group: ingroup vs. outgroup vs. self) within subject design. The ingroup was deﬁned as participant’s ethnic ingroup (European Canadian or East-Asian Canadian respectively) and the outgroup as people of two different and often marginalized ethnic groups (African Canadian and South-Asian Canadian).

5.4.2 Procedure

Participants arrived in the laboratory one at a time and provided informed consent. They were then ﬁtted with an electrode cap and I recorded 30 seconds of baseline EEG activity. Following baseline recording participants were asked to watch a series of videos while trying to sit as still as possible, not moving and simply passively observing, to ensure good EEG

\[^{3}\text{Since we define motor resonance as the decrease of mu-oscillations over sensory motor areas during baseline, it is necessary to have a proper baseline for each participants. Several participants did only display very weak mu-rhythm during baseline which resulted in non-significant overall mu-suppression during the self neutral action condition, creating the impression that participants' motor cortex was inactive during actual movement. To rectify this problem, we excluded all participants with baseline mu lower than 2.00. We chose this threshold by increasing it in .2 increments starting from 0 and choosing the point at which mu-suppression during self-action became significant.}\]
recording. The videos depicted different examples of ethnic ingroup and outgroup members performing a neutral, a positive and a threatening action. After the Video task, participants were asked to perform the same actions they just saw themselves. Finally, participants filled out a series of questionnaires and received a detailed debriefing.

5.4.3 Materials

5.4.3.1 Manipulation of action intent.

To manipulate the intent of the depicted actions, I used videos of ingroup and outgroup members repeatedly performing a neutral, a positive and a threatening action. The actors in the videos were of European Canadian, East-Asian Canadian, African Canadian, or South-Asian Canadian ethnicity. However, participants only saw either European Canadian or East-Asian Canadian actors depending on which of the two ethnicities constituted their own ethnic ingroup. In addition to actors from their own ethnic group, each participants saw the same set of African Canadian and South-Asian Canadian actors who constituted their ethnic outgroup. To ensure that participants did not react differently to African Canadian and South-Asian Canadian actors I conducted a 2(group:African Canadian vs. South-Asian Canadian) X 3(intent: neutral vs. positive vs. threat) on mu-suppression scores. This analysis resulted in no significant main effects of group or intent and no significant interaction (all p-values > .17). Moreover, participants did not show differences in mu-suppression in response to African Canadian and South-Asian Canadian actors in any of the intent conditions (all p-values > .35). To simplify subsequent analysis, I calculated compound mu-suppression scores for the outgroup by averaging African Canadian and South-Asian Canadian mu-suppression scores.
The videos showed three different male, university aged actors for each of the three ethnic groups (ingroup, African Canadian, and South-Asian Canadian), each standing in front of a white wall and performing all three actions.

For the neutral action, actors displayed a neutral facial expression and repeatedly lifted their right arm up and down. For the positive action, actors displayed a positive facial expression, and repeatedly made the “thumbs up” hand gesture with their right hand. Finally, for the threatening action, actors displayed an angry facial expression, repeatedly making the “giving someone the (middle) finger” hand gesture. Each actor was shown three times performing each action for 10 seconds at a time. The videos were presented in randomized order, randomized for both actor’s ethnicity and kind of action. Near the end of the session, participants performed the same three actions themselves for 30 seconds.

5.4.4 Electrophysiological recording and processing

To measure mu-suppression, I recorded the EEG from 32 Ag/AgCl sintered electrodes embedded in a stretch-lycra cap. Recording procedure and data processing were identical to the procedures used in Gutsell and Inzlicht (2010) and Gutsell and Inzlicht (2012) described here in chapters 2 and 3. I performed fast Fourier transformation and calculated power in the 8–13 Hz band for 30 seconds for each ethnic group and 30 seconds for self-action and for baseline. I then averaged the spectral data over the three outgroups.

5.5 Results

We calculated log-ratio scores of mu power during the observation of action and during baseline (log mu-oscillations during action observation/ log mu-oscillations during baseline) for
all conditions to control for differences in baseline mu-power. Consequently, more negative scores indicate a decrease in mu-rhythm compared to baseline, and thus more cortical activity. Since the resulting mu-suppression scores serve as an indicator of activation of neural sensory motor areas, I expected to find mu-suppression during movement and observation of movement only in the left hemisphere contralateral to movement of the right dominant hand. Thus, I performed statistical analysis only for electrode C3 located over the contralateral, left primary motor area.

Consistent with my hypotheses, and replicating the findings described in chapter 2 (Gutsell & Inzlicht, 2010), I found mu-suppression scores significantly different from zero \( t(22) = -2.10; p < .05 \) when participants looked at ingroup members performing neutral actions (\( M = -.18, SD = .40 \)), but not when participants looked at outgroup members performing neutral actions (\( M = -.11, SD = .40 \)) \( t(22) = -1.31; p = .20 \). Please see figure 8 for a depiction of the results.

Looking at the effects of intent I found significant mu-suppression in response to threatening ingroup members (\( M = -.18; SD = .38 \)) \( t(22) = -2.29, p < .05 \) and marginally significant mu-suppression in response to ingroup members displaying the positive action (\( M = -.16; SD = .40 \)) \( t(22) = -1.91, p = .07 \). Thus, participants showed mu-suppression all three intent conditions. Interestingly, I found a different pattern for the outgroup: Similar to the neutral condition, I did not find significant mu-suppression in response to positive actions (\( M = -.13; SD = .43 \)) \( t(22) = -1.49, p = .15 \), however, I did find significant mu-suppression, \( t(22) = -2.18, p < .05 \), in response to threatening outgroup actions (\( M = -18, SD = .40 \)). Taken together these findings suggest, that participants always showed mu-suppression indicative of motor resonance with ingroup members, but they only resonated with the actions of outgroup members when these actions were threatening.
Figure 8: EEG mu-suppression at left central scalp location (C3) during the observation of ingroup and outgroup members performing a neutral, positive and threatening action. Error bars represent ±1 standard error. Negative numbers denote more mu-suppression (i.e. more neural activity) at C3.

To further investigate the interplay of group membership and action intent, I conducted a 3 (action intent: neutral, positive, threatening) X 2 (Group: ingroup vs. outgroup) within subject ANOVA. I found no significant main effects and no significant interactions (All p-values > .12). Since, in the absence of any significant main effects and interactions, planned comparisons are interpretable unambiguously (Tybout et al., 2001), I looked at the simple effects of action intent. I found that only in the neutral condition did mu-suppression scores for the ingroup and the outgroup significantly differ from each other $F(1, 22) = 4.86, p < .05$. Whereas, both, the
positive $F(1, 22) = .53, p = \text{ns}$ and the threat condition $F(1, 22) = .01, p = \text{ns}$ did not show any difference for ingroup and outgroup actions. These findings draw a picture that is a little different from what we saw earlier. Again, the neutral condition replicates the findings from (Gutsell & Inzlicht, 2010), showing an ingroup bias in mu-suppression, such that participant show mu-suppression significantly less than they do with outgroup members. When the actions were intentional and had functional significance (either positive or negative), people showed mu-suppression in response to ingroup and outgroup members equally. These findings suggest that increasing motivational relevance does seem to override group biases in motor resonance.

Further supporting the hypothesis that when it comes to ingroup actions, the positive or negative intent of the action does not make a difference, I did not find significant differences between any of the action intentions (all $p$-values $> .44$) – participants resonated equally with neutral, positive and threatening ingroup actions. In contrast, for the outgroup condition I found a marginally significant $p = .07$ difference in mu-suppression between the neutral and the threat condition, suggesting that participants process threatening outgroup actions differently than neutral outgroup actions\(^4\). Although we have to be careful when interpreting this marginally significant effect, these findings are consistent with the pattern of the other findings in this study. In sum the data on threatening outgroup behavior suggests that the ingroup bias in motor resonance that is usually found, is no longer present when the outgroup’s actions are threatening.

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\(^4\) As outlined in chapter 3, left alpha asymmetry is related to approach motivation and has been shown to increase with anger (Carver & Harmon-Jones, 2009; Harmon-Jones & Sigelman, 2001). Therefore, looking at angry outgroup members could possibly have resulted to an increase in left-frontal alpha asymmetry. In theory such activation of the left-prefrontal cortex could have spread to more parietal areas, potentially affecting the mu-rhythm. To investigate alpha asymmetry as a possible confound, we calculated alpha asymmetry scores (log right alpha at F4 − log left alpha at F3) for all conditions. A $2(\text{group: ingroup vs. outgroup}) \times 2(\text{intent: neutral vs. positive vs. threat})$ on alpha asymmetry did not result in any main effects or interactions (all $p$-values $> .16$). In addition, controlling for threat related alpha asymmetry did not change the pattern of results for mu-suppression, and alpha-asymmetry did not correlate with the mu-suppression scores ($r = -.14; p = .52$).
Threatening outgroup behavior elicits significant mu-suppression, participants’ mu-suppression for threatening outgroup behavior was equally strong as for threatening ingroup behavior, and finally it seems as if participants show stronger mu-suppression in response to threatening outgroup actions than to neutral outgroup behavior.

My findings on positive outgroup behavior, however, are less conclusive. Positive outgroup behavior does not elicit significant mu-suppression, and mu-suppression in response to positive outgroup actions did not differ in strengths from mu-suppression in response to neutral outgroup behavior, suggesting that participants did not resonate with outgroup behavior, being it neutral or positive. However, I do find that participants display similar levels of mu-suppression for positive ingroup and outgroup actions. This could suggest that positive intent can overcome group biases in motor resonance. However, since mu-suppression in response to positive ingroup behavior was only marginally different than zero, it could also mean that participants did not resonate with the positive actions of either of the two groups. The results of this study, hence, suggest that motivational relevance does override group biases in motor resonance and that threat is more effective in doing so than is positivity.

5.6 Discussion

Research suggests that as a default, people do not resonate with the actions of outgroups (Gutsell & Inzlicht, 2010). Motivational relevance, however, could potentially override these group biases in motor resonance. Here I find that threatening actions performed by outgroup members are resonated with, suggesting that threat motivates people to resonate with others, even with those they would usually ignore. These findings are consistent with a functional perspective on person perception and motor resonance. According to this perspective, people
allocate their limited resources to those social targets who are relevant to their own goals, and who might provide functionally significant information (Ackerman et al., 2006; Ohman et al., 2001). Because, ingroup members are the ones we care about and who we interact most with (Fiske, 1992), outgroup members are often ignored. This reasoning is supported by findings showing that taking the perspective of an outgroup member can alleviate the group bias in motor resonance – when perspective taking brings the outgroup closer to the self (Galinsky, Ku, & Wang, 2005), perceivers will resonate with the actions of outgroup members (Chapter 3). It might, then, seem paradoxical that threatening behavior can reduce group biases in motor resonance since aggression and hostility should usually aggravate group biases and increase the distance between groups. Shouldn’t seeing threatening behavior in outgroup members increase the group bias in motor resonance, rather than reduce it?

A functional approach to motor resonance can account for this seeming contradiction: When someone who we do not feel close to and who we dislike, aggresses against us, it is particularly important for us to pay close attention and to resonate with him in order to make sense of his actions. Hence, high levels of prejudice and aversive emotions towards the particular outgroup member would, if anything, make their actions even more motivationally relevant. Demonstrating this dissociation between evaluation and allocation of processing resources, research shows that people dislike and stereotype outgroup members more when they are in competition to them (Judd & Park, 1988) and when they display aggression (Ackerman et al., 2006). At the same time, they show greater recognition accuracy for outgroup faces. Therefore, when one is in competition to the outgroup, or when the outgroup poses a potential threat, people no longer show the Cross-Category effect (Hugenberg & Sacco, 2008) – the tendency for recognition accuracy to be better for ingroup than for outgroup faces – consistently shown under neutral conditions. Hence, my findings provide support for a functional approach to motor
resonance in an intergroup context, suggesting that motivational relevance is the driving factor behind group biases in motor resonance.

5.6.1 Threatening Outgroup Behavior and Stereotypes

As outlined above, humans are generally prone to pay attention to negative and threatening information (Ito et al., 1998; Rozin & Royzman, 2001; Smith et al., 2003). In addition to this general bias, social categorization and stereotypes might uniquely contribute to the effects of threat in an intergroup context. People categorize others into groups in order to use these group labels as source of information (Macrae & Bodenhausen, 2000). Once a person categorizes someone as belonging to the outgroup, their perceptions of that person will be strongly influenced by the stereotypes of that social category (Fiske & Neuberg, 1990). In the present study, half of the actors in the outgroup category, were young Black men, while the other half were young South-Asian Canadian men. At least for young Black men there is a wealth of evidence suggesting that this category is associated with threat both implicitly (Hugenberg & Bodenhausen, 2003; Maner et al., 2005; Trawalter, Todd, Baird, & Richeson, 2008) and explicitly (Cottrell & Neuberg, 2005). This association between Black men and threat can also be seen on the neural level. For example, the amygdala – a brain region responsive to threat (Davis, 2006) but also motivational significance (Cunningham et al., 2004), is selectively activated by the sight of Black male targets compared to White male targets (Cunningham et al., 2004; Wheeler & Fiske, 2005). Given how deeply ingrained these threat associations seem to be, they might also have contributed to my current findings. Since, in addition to the more general negativity bias, outgroup members, and Black’s in particular, are associated with threat, threatening outgroup actions might be exceedingly motivationally relevant compared to positive actions performed by outgroup members or threatening actions performed by ingroup members.
5.6.2 Limitations and Future Directions

My findings suggest that threatening outgroup behavior is motivationally relevant enough to be resonated with, while positive outgroup behavior is not. Theoretically it makes sense that threat would be a powerful tool to increase motivational relevance of outgroup behavior because of the negativity bias, and stereotypes associating the outgroup to threat. Consequently simply matching the intensity of the negative and positive stimuli without also considering the effects of group membership on stimulus perception might be insufficient. For my design I chose approximately equally intense actions for the positive and threat conditions that is I matched them independent of group membership, but the complexities of emotion perception in intergroup settings might call for a different approach. In a series of studies, Weisbuch and Ambady (2008) showed that participants react with a negative emotional response such as fear to joy expressions of outgroup members, and with positive emotions to fear expressions of outgroup members, potentially because happiness of outgroup members may signal a disadvantage for the ingroup, while fear signals an advantage. These findings suggest that group membership alters the signal value of emotional displays (Weisbuch & Ambady, 2008). Hence, I cannot be sure how participants perceived the positive actions of outgroup members, which makes conclusions about the effects that positive outgroup actions can potentially have on motor resonance difficult. More research is needed on motor resonance for positive outgroup actions.

5.7 Conclusions

I presented research showing that motor resonance is limited to the ingroup, but it is available for outgroup behavior when it has motivational significance for the observer. Who we resonate with, thus, is not fixed but rather, can change with the context. Depending on the
situation the actions and experiences of outgroup members might be equally or even more motivationally relevant than those of ingroup members. In such cases, people should resonate with outgroup members who they would otherwise ignore.
6 General Discussion and Conclusions

Understanding other’s action intentions and intuitively picking up on other’s inner states, is a central human capacity. One important underlying mechanism is motor resonance – the activation of the observer’s motor system during observation. Essentially, by mapping the other’s actions and facial expressions onto their own motor system, observers gain an intuitive and richer representation of what it is like to perform the action and to express the emotion, because this representation includes not only the action pattern, but also information about the proprioceptive states, the action tendencies, and the associated emotional and motivational states (Iacoboni, 2005; Keysers et al., 2010).

The four studies described here investigate the dynamics of motor resonance in an intergroup context. They provide insight into how motivational relevance can limit the amount of motor resonance in response to social outgroup members and under which circumstances motivational relevance, and with it motor resonance for outgroup members, can be increased. Specifically, study one shows that people resonate with observed ingroup actions, but not with outgroup actions, and this group bias in motor resonance is aggravated with increasing levels of prejudice. Study 2 examined a potential consequence of such a lack in motor resonance for the outgroup: reduced affect sharing. Participants showed EEG frontal asymmetry patterns associated with aversive motivational states in response to videos of ingroup members displaying the experience of sadness, but not when seeing sad outgroup members.
After having established an ingroup bias in motor resonance and affective sharing in study one and two respectively, I set out to investigate what variables might facilitate motor resonance. In study 3 I found that having participants take the perspective of an outgroup member can increase motor resonance in response to other outgroup members’ actions. At the same time, study four suggested that when outgroup behavior is threatening, people do resonate with outgroup members. Together, the findings of these latter two studies suggest that motivational relevance plays an important role in the ingroup biases in motor resonance: When I increase the motivational relevance of outgroup members by bringing the outgroup closer to the self through cognitive perspective taking, participants resonate with outgroup members. Demonstrating the same underlying mechanism, I also find that when I increase the motivational relevance of outgroup members’ actions by making the action threatening, people again start to resonate with outgroup members.

In sum, people tend to resonate with actions that have functional significance. Most commonly, these are the actions of ingroup members. Consequently, people often ignore the actions of outgroup members, depriving intergroup interactions of the potential many benefits of motor resonance, and possibly hampering smooth communication and cooperation between members of different groups. The good news is that there are a multitude of potential reasons for why outgroup actions can become motivationally relevant leading to motor resonance across group boundaries.

6.1 Implications of a lack in motor resonance:

Since by default people do not seem to resonate with outgroup members, it is important to understand the potential implications. Thus far, to my knowledge, no research has directly...
tested the consequences of group biases in motor resonance, and only a few studies exist that look at the consequences of a lack in motor resonance in general. However, there are some findings and theoretical accounts that can provide clues.

Basic research on the function of mirror neurons can give some indication. Above I described in detail evidence that suggests mirror neurons’ involvement in action understanding. To summarize, mirror neurons are sensory motor neurons with the acquired property to respond to the sight of motor acts in addition to the actual performance of the motor act the specific mirror neuron is coding (Keysers & Perrett, 2004). Because mirror neurons are essentially motor neurons fully integrated in the sensory motor system and with connections to visual areas, activation of mirror neurons during observation could potentially provide insight into the internal states that are associated with the action (Schippers & Keysers, 2011), including action tendencies, basic intentions, and goals, as well as the sense of movement, the feeling of touch, and object properties (Keysers et al., 2010). For example, people can usually estimate the weight of an object simply by observing someone else lifting it, presumably by using the other’s movement patterns as indicators for how heavy the object is. Interestingly, when research participants’ somatosensory cortex is stimulated with disruptive TMS, leading to decreased sensitivity of sensory motor neurons, participants weight estimation ability decreases (Keysers, 2012). This finding suggests that mapping the other’s actions on one’s own motor system facilitates an intuitive understanding of what it means to perform the action.

In addition to action understanding mirror neurons might be involved in synchrony, mimicry, and joint actions, three related but different processes. Synchrony is the coupling of interacting individuals’ rhythmic movements, such as when the clapping of audiences slowly turns into a synchronized rhythm, or when research participants subconsciously start
synchronizing their rocking in rocking chairs (Richardson, Marsh, Isenhower, Goodman, & Schmidt, 2007). Synchrony has been associated with feelings of rapport (Bernieri, Davis, Robert, & Knee, 1994) and affiliation (Hove & Risen, 2009), and has been shown to promote cooperation (Valdesolo, Ouyang, & DeSteno, 2010). Mimicry, on the other hand, is the subconscious and automatic imitation of another’s motor movements, postures and mannerisms (Chartrand & Bargh, 1999). Hence mimicry differs from synchrony in that it involves more complex behavior, not being limited to rhythmic movement, and that it is a one sided process during which one individual imitates another individual, rather than a bidirectional synchronizing between two individuals. Mimicry has been associated with increased liking (Chartrand & Bargh, 1999) and feelings of closeness (van Baaren, Holland, Kawakami, & van Knippenberg, 2004).

Finally, several processes have to come together for joint action. Joint action requires people to coordinate their actions with others to reach a common goal (Sebanz, Bekkering, & Knoblich, 2006). To this end, people first have to direct their attention to the same events. Then, they must form representations of the other’s actions, goals, and intentions in order to predict the outcomes of those actions, as well as what the other person is going to do next. Finally, people have to integrate the other’s actions into their own action planning (Knoblich & Sebanz, 2006).

It easily becomes apparent, that synchrony, mimicry and joint action all have one important aspect in common: They require the co-representation of the other’s action. It does, of course, make intuitive sense that motor resonance is the common underlying process. Several researchers have suggested just that (Iacoboni, 2009; Knoblich & Sebanz, 2006; Obhi & Sebanz, 2011), and there is also initial empirical evidence in support for a causal contribution of motor resonance to action co-representation and imitation. Specifically, two studies found that when
disruptive rTMS is administered to mirror neuron areas, people show reduced accuracy in an intentional imitation task (Catmur, Walsh, & Heyes, 2009; Heiser, Iacoboni, Maeda, Marcus, & Mazziotta, 2003).

One final consequence of a lack in motor resonance could be reduced empathy. People do not only map others’ body movements onto their own motor cortex, but also others’ facial expressions, which in turn should lead to a co-representation of others’ facial expression along with the associated internal states including the respective emotion. By showing that participants do not display matching prefrontal – asymmetry patterns when observing outgroup members experiencing sadness, my findings support the notion that biases in motor resonance could indeed lead to biases in affect sharing. Moreover, recent findings suggest that the somatosensory cortices are also involved in the mirroring process. These findings show that when people witness the sensations, actions and somatic pain of others, they consistently experience matching activation in their own somatosensory cortices (Keysers et al., 2010). In addition, single cell recordings in monkeys have found mirror neurons in the somatosensory cortex (Ishida, Nakajima, Inase, & Murata, 2010). Thus, a lack in motor resonance could be associated with a lack in somatosensory resonance, leading to reduced sharing of the other’s sensations and pain. Indeed, Xu and colleagues (2009) found that participants did show matching activation in the neural areas usually active during the experience of pain when looking at videos of outgroup members’ hands getting pricked with a needle, but they did not show indication of such vicarious experience of pain when looking at outgroup members receiving painful needle pricks.

The degree to which synchrony, mimicry, joint action and empathy are actually dependent on motor resonance and whether motor resonance is necessary for these phenomena remains an open question (for a detailed discussion see Gallese et al., 2011). However, if the
answer to this question is even only partially “yes”, then the group biases in motor resonance observed here could have profound consequences to how we interact and cooperate with, and to how we affiliate with and feel about others who are not part of the same social group.

6.2 Malleable motor resonance

The current work not only has implications for intergroup interactions and perception, but also contributes to our knowledge of motor resonance. Motor resonance is a very basic mechanism and has often be shown to happen automatically, without much influence from top-down processes (e.g. Chong, & Mattingley, 2009; Fadiga et al., 1995; Iacoboni, 2005; van Schie et al., 2008). However, relatively few processes are completely independent from top-down information. Nonetheless, only a few studies have investigated the nature of top-down influences on motor resonance. For instance, motor expertise and familiarity with the action seem to influence motor resonance. Compared to novices, professional basketball players show more motor resonance when watching other players play, and this increase predicts accuracy of their evaluation of free shots (Aglioti, Cesari, Romani, & Urgesi, 2008). Similarly, research participants show more motor resonance in tasks that involve unfamiliar rather than familiar actions (Calvo-Merino et al., 2005). Further, context seems to be another factor that can influence motor resonance. For example Iacoboni and colleagues (2005) found that when participants were instructed to infer the intention of actions they showed more motor resonance, than when they were instructed to observe the same actions passively. Likewise, research participants show less motor resonance in non-interactive situations than interactive situations (Oberman et al., 2008) and in situations that require complementary responses rather than non-complementary ones (Sartori et al., 2011).
In sum, we have evidence that mirror neuron activity and motor resonance are not entirely driven by bottom up processes. Instead, they are susceptible to relatively basic, top-down influence such as experience and context. Yet, the extent to which motor resonance can be influenced by more abstract and complex factors such as attitudes or mindsets is still relatively unexplored. To my knowledge modulation of the neural mirroring has, thus far, only been investigated in the domain of empathy for pain (e.g. Hein et al., 2010; Singer et al., 2006; Xu et al., 2009), and by looking at behavioral phenomena related to motor resonance, such as mental co-representation of actions (Müller et al., 2011) and mimicry (Leighton, Bird, Orsini, & Heyes, 2010; Likowski et al., 2008). To my knowledge only one study has directly investigated motor resonance using neuroimaging and shown that more complex mental states, in this case self-construal, can influence motor resonance (Hogeveen & Obhi, 2011). Hence, the research presented here can make an important contribution to the understanding of motor resonance. I show that not only is motor resonance influenced by social categorization, but it can also be influenced by culturally learned prejudice and by temporarily induced mindsets. After all, motor resonance, like many other basic perception processes before, has turned out not to be as automatic as previously thought to be, but instead turned out to be susceptible to the multifaceted and rich world of higher order cognitive processes that constitute human social cognition.

6.3 Limitations and future directions

There are still several open questions regarding motor resonance and the influences that group categorization, prejudice and motivational relevance exert on it. One important extension of my research would be to replicate the effects with different groups. I chose ethnicity as the defining factor of group membership, but of course there are multitudes of potential other group memberships. In fact, any minor difference between people can be enough to elicit social
categorization and the division into ingroup and outgroup (Diehl, 1990). Ethnicity is often tightly connected with prejudice, and I showed that prejudice can affect motor resonance (Gutsell & Inzlicht, 2010). Specifically, I showed that prejudice is negatively associated with motor resonance for the outgroup, such that more prejudiced people resonate even less with outgroup members, and the amount of motor resonance is reduced for outgroups that are disliked in society. It would be important to see how motor resonance changes in respect to group membership when the group in question is not a marginalized group, such as when the minimal group paradigm is used. Moreover, the specific nature of the stereotypes associated with the outgroup might also influence motor resonance and the effects of perspective taking and threat on motor resonance. According to the stereotype content model (Fiske, Cuddy, Glick, & Xu, 2002), stereotypes can be described by two dimensions – warmth and competence. These dimensions are crucial, because when people meet others, two concerns are of primary importance: whether the other has well-meaning or hostile goals related to the self or the ingroup (warmth), and whether they have the capability to pursue those goals (competence). Only the ingroup and close allies score high on both, warmth and competence. Outgroups can either be high in competence and low in warmth such as Black professionals, businesswomen, Jews and Asians, they could be low in competence and high in warmth, such as housewives, and the elderly, or they could be low on both, such as homeless people or welfare recipients. It seems likely that stereotype content could influence motor resonance. For example, people show less neural activity in brain areas usually involved in processing of social targets, when they look at outgroup members who are stereotyped as low in warmth and low in competence (Harris & Fiske, 2006). Since people low in competence, are less likely be motivationally relevant, motor resonance for outgroups might depend on whether they are perceived as high in competence or not. Similarly, the effects of threat might work differently for different outgroups, such that it
would only effectively increase motor resonance when the aggressor is also seen as competent to actually follow through with the threat. People’s social world is complex and future studies on intergroup motor resonance should take this complexity into account.

An important question that requires more investigation is the effect that motivational relevance has on motor resonance. Thus far we’ve investigated two very distinct factors, one related to prosocial behavior and affiliation, the other one related to aggression and threat. I chose these two manipulations specifically because they differed on these two dimensions, but because they are so different, each might have unique effects on motor resonance. For example, threat might be an especially powerful motivator because of the negativity bias, but it might also operate differently depending on the specific group membership of the target and depending on context. Similarly, we know that perspective taking exerts its beneficial effects through an increase in self-other overlap (Galinsky et al., 2005), but we do not yet fully understand how exactly closeness and affiliation are related to motivational relevance. Hence, it would be important to look at motivational relevance in its pure form without possible confounds. Incentives or variations in task relevance of other’s actions might, for instance, be a way to subtly and in small increments vary motivational relevance directly.

Finally, another extension of my work would be to look at motor resonance during real interactions. All four studies presented here used videos. Although the use of videos ensured a controlled environment, making it easy to exactly match changes in motor resonance with specific events during stimulus presentation, they remain only a simulation of real interpersonal contact. One cannot interact with a person in a video, but motor resonance is a social process, involved in action preparation and potentially joint action (Knoblich & Sebanz, 2006). Hence, it would be important to conduct studies that measure motor resonance during observation of real
interaction partners, giving participants the opportunity to react to the target’s actions, or to coordinate their actions with them. Such research might potentially lead to results very different from those that can be obtained using videos, both in terms of motor resonance in response to outgroups, but also on the effects of perspective taking and threat. Real interactions would also enable us to look at both the observer and the target. What is the experience of not being resonated with like? Although the opportunities for meaningful and complex interactions in the laboratory, especially when measuring brain activity, are limited by the requirements of the measures, moving towards a more natural social experience holds many promises for future research.

6.4 Conclusions

We presented research suggesting that, as a default, people do not resonate with ethnic outgroup members, nor do they share their affective and motivational states. However, once an outgroup member becomes motivational relevant, either because the observer is in a perspective taking mindset, or because the outgroup member’s behavior poses a potential threat, people start resonating, thereby becoming more sensitive to the inner states of outgroup members.

My findings advance current theoretical understanding of cross-group interactions showing that a basic process underlying action perception and emotional contagion might be limited to the ingroup and will only be available for the outgroup in certain circumstances in which motivational relevance is salient. In addition, my findings contribute to the understanding of motor resonance by shedding light on the factors that facilitate and hamper motor resonance.

Additionally, these findings have practical implications: with the rise in cultural and ethnic diversity in societies all around the world, cross-group encounters will become
increasingly common, and will be part of most people’s everyday life. Better understanding the
dynamic processes underlying and affecting an intuitive understanding of others, can gain
important knowledge that might help to develop strategies to improve cross-group encounters.
References


