Exploring Online and Offline Social Hierarchies and their Influence on the Motor Resonance System

EXPORING ONLINE AND OFFLINE SOCIAL HIERARCHIES AND THEIR INFLUENCE ON THE MOTOR RESONANCE SYSTEM

By Sumeet Farwaha, Honours B.A.

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AUTHOR: Sumeet Farwaha
SUPERVISOR: Dr. Sukhvinder S. Obhi
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Lay Abstract

Previous research has shown that individuals of varying levels of social rank exhibit differences in motor resonance. Motor resonance refers to the activation of one's motor system, when they observe another person perform an action. This system is believed to play an important role in our ability to understand and process social information about others. Even though the tendency to automatically imitate observed actions can be viewed as an extension of this process, no previous studies have explored whether there are imitative differences between high and low status adults from the local community (as opposed to university students) or considered whether online (as opposed to real-world) social rank might also modulate this system. As such, this thesis will aim to bridge these gaps and contribute meaningfully to the existing literature on this topic. The findings reported in this thesis suggest that individuals of low online and real-world rank exhibit increased automatic imitation and motor system activity during action observation. In addition, low online status individuals were found to mimic the actions of others significantly more during social interaction than high online status individuals. Overall, this dissertation furthers our understanding on how online and offline social hierarchies modulate this important system.

Abstract

Previous physiological work has established that factors such as power and status modulate the motor resonance system. Motor resonance is classified as motor activity that occurs during action observation in the absence of action execution. However, no previous work has explored whether these factors have downstream behavioural effects on automatic imitation using a community sample (as opposed to a university student sample). In addition, no prior work has examined whether online social hierarchies (as opposed to real-world social hierarchies) also modulate this system. As such, this dissertation aims to corroborate and extend on previous physiological work in the field and explore whether online status has similar downstream effects on motor resonance compared to previously documented effects of offline (real-world) status using behavioural and physiological methods. In chapters 2-3, I provide evidence from community-based behavioural studies that suggest high socioeconomic status (SES) and high power individuals are less susceptible to automatically imitating "other-oriented" social stimuli compared to their low SES and low power counterparts. In chapters 4-5, I show that Instagram followers exhibit significantly greater motor cortical output (via transcranial magnetic stimulation induced motor-evoked potentials) during action observation compared to Instagram leaders. I also show that this effect can be extended behaviourally using the automatic imitation task, whereby Instagram leaders are less susceptible to automatically imitating "other-oriented" social stimuli compared to Instagram followers. In chapter 6, I begin to explore the effect of online status on behavioural mimicry. I show that Instagram leaders exhibit reduced behavioural mimicry during an online interaction compared to Instagram followers. In the final chapter of this dissertation, I summarize the contributions and limitations of each chapter and recommend future avenues of research. Overall, this dissertation furthers our understanding on how online and offline social hierarchies modulate the motor resonance system using behavioural and physiological methods.

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Declaration of Authorship

I, Sumeet Farwaha, declare that this thesis titled, “Exploring Online and Offline Social Hierarchies and their Influence on the Motor Resonance System”, and the work presented in it are my own. The thesis consists of a general introduction, five empirical chapters, and a general discussion. Four out of the five chapters are published in peer-reviewed scientific journals. I am the primary author of all seven chapters. I conceptualized and designed each experiment in consultation with my supervisor, Dr. Sukhvinder S. Obhi. For each study, I was the primary individual responsible for creating stimuli, collecting data, supervising data collection by undergraduate students, analyzing the data, and preparing the manuscripts.

This thesis includes four published research articles with permissions from Springer Publishing Company, Frontiers, and Guilford Press.

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Chapter 1

General Introduction

1.1 Introduction

A significant amount of literature in the field of social cognitive neuroscience has suggested that action observation and action execution are tightly linked (Jeannerod, 1999; Gallese, 2003; Brass & Heyes, 2005). Indeed, it has consistently been shown that when an individual observes another perform an action, it directly primes the corresponding motor representation in the observer (Prinz, 1997; Jeannerod, 1999; Gallese, 2003; Brass & Heyes, 2005). Several researchers have argued that this system of motor resonance forms the basis for understanding the actions of others and social cognition (Gallese, 2003; Rizzolatti & Craighero, 2004; Brass & Heyes, 2005). Importantly, researchers have explored this system further by examining differences in automatic imitation (a behavioural index of motor resonance) (Obhi et al., 2014) and the excitability of the motor cortex in an observer's brain during action observation (via transcranial magnetic stimulation (TMS) induced motor-evoked potentials) (Hogeveen et al., 2014). Recent studies have also begun to explore how various social factors such as power and status may modulate this system using physiological methods (Hogeveen et al., 2014; Varnum et al., 2016). However, no previous work has explored whether such effects on brain activity translate into behaviour using a community sample (as opposed to a university sample) or considered how other forms of social hierarchy such as online status may have similar downstream effects on motor resonance compared to previously documented effects of offline (real-world) status (Varnum et al., 2016). As such, the aim of this dissertation is to corroborate and extend on previous physiological work in the field and begin to explore how both online and offline (real-world) social hierarchies influence the motor resonance system using behavioural and physiological methods. This dissertation consists of a general introduction, five empirical chapters, and a general discussion. Importantly, each empirical chapter contains a preface section, which sets the context and draws out the overall implications of the work.

In section 1.2 of this general introduction, I discuss real-world (offline) and online social hierarchies and their link to motor resonance. In section 1.3, I discuss motor resonance and its link to social factors. In section 1.4, I discuss automatic imitation and its link to the motor resonance system and social factors. In section 1.5, I discuss behavioural mimicry and its link to the motor resonance system and social factors. Finally, section 1.6 of this general introduction describes how each subsequent chapter of this dissertation contributes meaningfully to the existing literature.

1.2 Real World and Online Social Hierarchies

When examining the literature on offline (real-world) social hierarchy, it is evident that there exists a dependence asymmetry between the powerful and powerless in society (Fiske, 2001; Keltner et al., 2003). Specifically, it has been shown that the former control the valued social, economic, and physical outcomes of others, while the latter depend relatively more on others for promising outcomes (Fiske, 2001; Keltner et al., 2003). According to previous work in the field, this dependence asymmetry contributes to differences in how these individuals process information about others (Fiske, 1993; Smith & Trope, 2006; van Kleef et al., 2008). Since powerless individuals cannot freely pursue their own goals, due to their reliance on others for positive outcomes, they are naturally more attuned to social stimuli than their powerful counterparts (Guinote, 2007). This finding is in line with previous physiological work that suggests low power individuals resonate with the actions of others significantly more than their high power counterparts (Hogeveen et al., 2014).

Although they are considered separate constructs, status, like social power, is also related to an individual's rank in society. Status can be linked to power by the fact that high status individuals can also control the social outcomes of others, through their ability to transfer respect and esteem to them via social interaction (Adler et al., 2000; Fiske & Berdahl, 2007). According to previous work in the field, an individual's socioeconomic status (SES) is based on a combination of objective (e.g., family income, education, etc.) and subjective measures (e.g., where they feel they rank relative to their peers in society) (Adler et al., 2000; Varnum et al., 2016). Like power, individuals of varying levels of socioeconomic status also exhibit differences in how they process information about others (Kraus et al., 2012). Specifically, it has been shown that since low socioeconomic status individuals rely on others for resources and support, they are more sensitive to "other-oriented" stimuli compared to their high socioeconomic status counterparts (Kraus et al., 2012). This finding is in line with previous physiological work that has suggested low SES individuals resonate with the actions of others significantly more than their high SES counterparts (Varnum et al., 2016).

Although there has been a significant amount of work on status and power in face-to-face interactions, little is known about how online social status modulates motor resonance. Indeed, the rise of the Internet introduced the world to newer forms of social interaction, such as instant messaging and e-mail. However, today that picture is quite different, as individuals use popular social media platforms such as Instagram for sharing personal content (pictures, videos, etc.) and communicating with other users (Sherman et al., 2016). In addition to entertainment, these social media platforms have also introduced a new form of social hierarchy, especially on Instagram, where an individual's online status can be readily monetized through their daily posts via industry sponsorships (Konstantopoulou et al., 2019). Indeed, those with the most followers on platforms such as Instagram (also referred to as "influencers") tend to profit the most, while those with fewer followers do not (Konstantopoulou et al., 2019). Similar to the link between real-world status and power, individuals with high online status also have the ability to control the social outcomes of other users on the platform via online interaction. For example, a high online status individual on Instagram can simply "follow" or "like" another user's content on the platform. By doing so, they can confer higher online status to the recipient, in the form of new potential followers. As such, it is evident that high online status individuals can control the valued social outcomes of lower status individuals on the platform.

Since social media platforms are now very popular in society, important questions arise about the similarities and differences between online and real-world social interactions. As such, this dissertation aims to examine whether online status has similar downstream effects on motor resonance compared to previously documented effects of offline (real-world) status using behavioural and physiological methods (Chapters 4-6). The findings reported in this dissertation will bridge these gaps and contribute meaningfully to the existing literature on this topic.

1.3 Motor Resonance

Motor resonance generally refers to the finding that when an individual observes another perform an action, their motor cortex becomes activated as if they were performing the action themselves (Brass et al., 2001; Rizzolati & Craighero, 2004). As mentioned earlier, research has now begun to explore how power and status modulate the motor resonance system using physiological methods (Hogeveen et al., 2014; Varnum et al., 2016). Two of the most popular physiological tools used by researchers to examine motor resonance during action observation are transcranial magnetic stimulation (TMS) and electroencephalography (EEG). TMS is a physiological tool used by researchers to elicit motor-evoked potentials (MEPs) in corresponding muscles while a participant observes an action (Fadiga et al., 1995). Researchers measure these MEPs using electromyography (EMG) and monitor any differences in their amplitude, as they are thought to index the excitability of the motor cortex in the observer's brain (a physiological index of motor resonance) (Fadiga et al., 1995). Previous work by Hogeveen and colleagues (2014) has examined how social power priming modulates motor resonance during an action observation task. In their study, participants were primed to high, low, or neutral levels of social power using an essay priming technique. In the high power condition, participants were asked to write about a time they had power over someone else. In the low power condition, participants were asked to write about a time someone else had power over them. In the neutral power condition, participants were simply asked to write about what they did yesterday. Crucially, it was found that participants in the high power group showed reduced motor resonance (as indexed by TMS-induced MEPs) during action observation (a video of an on-screen hand squeezing a rubber ball) compared to the low power group. These findings support that high power individuals are less sensitive to "other-oriented" actions compared to their low power counterparts (Galinsky et al., 2003; Guinote, 2007).

Other work has used electroencephalography (EEG) as a tool to examine differences in motor resonance between groups. Specifically, researchers have used EEG to record brain activity from corresponding sensorimotor regions of the brain during action observation or execution (referred to as Mu rhythm) (Hobson & Bishop, 2016; Hager, Yang, & Gutsell, 2018). Importantly, it has been shown that when an individual observes or executes an action, this Mu rhythm becomes desynchronized, due to underlying neurons no longer firing in unison (Hobson & Bishop, 2016; Hager et al., 2018). This reduction in synchronous neuronal activity leads to a reduction in power of the Mu rhythm (also referred to as Mu-suppression) (Hobson & Bishop, 2016; Hager et al., 2018). Since Mu-suppression has been found when an individual observes or performs an action, it has been used as an EEG correlate of motor resonance by researchers (Hobson & Bishop, 2016; Varnum, et al., 2016; Hager et al., 2018). Previous work by Varnum et al. (2016) has examined differences in Mu-suppression during action observation (a video of an on-screen hand opening and closing) between low and high SES participants. Participants were classified as high or low SES based on their highest parental education, family income, and subjective status. Overall, they found that low SES individuals exhibited stronger Mu-suppression during action observation compared to their high SES peers. In other words, low SES individuals were more socially attuned to "other-oriented" stimuli compared to their high SES counterparts. As such, it is evident that both status and power modulate the motor resonance system during action observation in similar fashion. However, it is still unclear whether these effects of power and status can be observed behaviourally (as indexed by the automatic imitation task). In addition, since these physiological studies have solely relied upon an undergraduate student sample, it is equally as important to explore whether these effects can be observed using a community-based sample (as opposed to undergraduate students), in order to enhance the generalizability of the results. This dissertation aims to bridge these gaps in the literature.

1.4 Automatic Imitation

Researchers in the field of social cognitive neuroscience have also used the automatic imitation task (AIT) to demonstrate that action observation primes the corresponding motor representation in the observer (Blakemore & Frith, 2005; Heyes, 2010). In this behavioural task, participants are asked to make specific finger actions in response to numerical cues presented on a computer screen. For example, if they see the number "1" appear, they are asked to lift and re-press their index finger as quickly as possible. If they see the number "2" appear, they are asked to lift and re-press their middle finger as quickly as possible.

While participants are making responses to these numerical cues, they also encounter a super-imposed hand on the computer screen that is performing either congruent or incongruent actions to what they are required to execute. Participants are generally faster and more accurate during congruent trials, and slower and less accurate during incongruent trials (Brass et al., 2001; Heyes, 2010). After completion of this task, a participant's reaction time (RT) and error rate (ER) are assessed. More specifically, researchers examine differences in the AIT interference effect score (calculated by subtracting their RT/ER during congruent trials from their RT/ER during incongruent trials) during the task (Obhi et al., 2014). It has been consistently shown that this score reflects the degree of interference experienced by participants due to the movements of the on-screen hand, which is thought to be due to the automatic activation of the observed action (a behavioural index of motor resonance) (Blakemore & Frith, 2005; Heyes, 2010). As such, the interference effect can be used as an index of self–other processing, where high levels of interference indicate an increased susceptibility to observed actions.

Interestingly, many researchers have found that various social factors modulate performance on the automatic imitation task. Obhi and colleagues (2012) found that participants who scored higher on the Narcissistic Personality Inventory (NPI-16) experienced significantly less interference during the AIT compared to participants who scored much lower on the personality inventory. Other work by Leighton et al. (2010) found that pro-social priming led to an increase in the interference effect compared to anti-social priming, supporting that social attitudes modulate automatic imitation. Another study by Gleibs et al. (2016) found that when interacting with an expectation of cooperation, imitation was stronger for an ingroup target compared to an outgroup target.

Even though previous physiological work has found that social factors such as power and socioeconomic status can modulate motor resonance during action observation, it is unclear whether these effects can be 1) extended behaviourally (as indexed by performance on the AIT) and 2) observed in a sample of adults from the local community, as opposed to an undergraduate student sample. Unfortunately, a significant amount of existing work in the field has relied solely on undergraduate participants (between the ages of 18 to 25), who are typically from western, educated, industrialized, rich, and democratic (WEIRD) societies (Henrich et al., 2010). As a result, their findings may not be as generalizable to the broader population compared to work based on a diverse, community-based sample of older adults (Henrich et al., 2010). As such, this dissertation will aim to bridge this gap in the literature by using a sample of adults (over the age of 30) from the local community for the behavioural studies presented in Chapters 2 and 3 of this dissertation. Furthermore, this dissertation will also contribute to the current literature by exploring whether the effects of offline (real-world) social hierarchy are concordant with the effects of online social hierarchy on automatic imitation (Chapter 5).

1.5 Behavioral Mimicry

Behavioural mimicry refers to phenomena where individuals tend to copy the actions of others during a social interaction (Chartrand and Bargh, 1999). Previous work has shown that mimicry typically occurs within 3-5 seconds of the initial action (Chartrand and Bargh, 1999; Cheng & Chartrand, 2003; Hogeveen & Obhi, 2012). Research by Chartrand and Bargh (1999) argues in favour of a perception-behaviour link, where action observation primes the corresponding motor representation in the observer, which then facilitates mimicry behaviour. Importantly, this link between behavioural mimicry and motor resonance has been supported by more recent physiological work in the field. Indeed, Hogeveen and Obhi (2012) reported that participants who displayed mimicry during social interaction, exhibited greater motor resonance (as indexed by TMS-induced MEPs) during a subsequent action observation task, compared to participants who did not display mimicry. Importantly, these results provide direct support for the idea that motor resonance underlies the perception-behaviour connection, which ultimately facilitates mimicry behaviour during an interaction (Hogeveen & Obhi, 2012).

Previous work has found that behavioural mimicry is modulated by a variety of social factors. For example, it has been found that high self-monitors tend to exhibit greater mimicry behaviour during a social interaction compared to low self-monitors (Cheng & Chartrand, 2003). Self-monitoring refers to the amount of effort an individual exerts to maintain their public image and behave appropriately in their social environments (Cheng & Chartrand, 2003). Since high self-monitors have been shown to frequently search for social cues in their environment to guide their behaviour, they may naturally be more sensitive to the actions of others compared to their low self-monitoring counterparts (Cheng & Chartrand, 2003). Other related work has found that individuals primed to an independent self-construal style (SCS) tend to exhibit less mimicry behaviour during a social interaction compared to individuals primed to an interdependent self-construal style

(SCS) (van Baaren et al., 2003). Self-construal style generally refers to whether one defines their *self* as separate or closely linked to others (van Baaren et al., 2003). Indeed, individuals with an independent SCS define themselves based on their own abilities (and accomplishments) without the inclusion of others, while individuals with an interdependent SCS define themselves based on their relationships and sense of connection with others (van Baaren et al., 2003). As such, individuals with an interdependent SCS may be more socially attuned to the actions of others during a social interaction compared to individuals with an independent SCS.

Most mimicry studies examine in-person interactions between a participant and their interaction partner (typically a confederate who performs a specific action) (Chartrand & Bargh, 1999). However, no previous work has examined whether social mimicry occurs during an online interaction; an interaction that occurs over a video conferencing platform such as ZOOM. This is surprising, since millions of people around the world have relied on this platform to stay connected to friends, family, and co-workers during the COVID-19 pandemic (Wiederhold, 2020). As such, this dissertation will aim to bridge this gap in the literature by exploring 1) if social mimicry occurs during an online interaction, and 2) whether differences in online status between a participant and their interaction partner will influence the amount of mimicry exhibited by the participant during the interaction (Chapter 6). As such, the findings reported in this dissertation will contribute meaningfully to the existing literature by examining whether online status modulates behaviour beyond traditional laboratory-controlled conditions (e.g., automatic imitation task).

1.6 Outline of Dissertation

There are a total of 5 empirical chapters in this dissertation. Chapter 2 presents an experiment that examines how socioeconomic status modulates automatic imitation. Importantly, this study uses a community-based sample in contrast to previous studies that have only relied on an undergraduate sample. As predicted, we found that high SES individuals showed significantly less interference effect on the automatic imitation task (AIT) compared to their low SES peers. This finding is concordant with previous physiological work that suggests low SES individuals resonate with the actions of others significantly more compared to their high SES counterparts (Varnum et al., 2016). This study is the first to examine differences in automatic imitation based on SES in adult participants from the local community.

Chapter 3 presents an experiment that corroborates and extends on the findings reported in Chapter 2. Specifically, Chapter 3 examines how SES and social power may interact and modulate automatic imitation. Similar to Chapter 2, adult participants were recruited from the local community in order to increase the generalizability of the results. Our findings indicate that priming participants of low and high SES to varying levels of social power did not differentially modulate automatic imitation. However, we did find that both high SES and high power participants exhibited a significantly lower interference effect during the AIT compared to individuals of low SES and low power. These findings are concordant with previous physiological work that has shown that both high SES and high power individuals are less socially attuned to others compared to their low SES and low power peers (Hogeveen et al., 2014; Varnum et al., 2016). This is the first study to examine whether there is an interaction between chronic socioeconomic status and primed social power on automatic imitation using an adult sample from the local community.

While Chapters 2 and 3 focus on examining how status and power modulate automatic imitation, Chapters 4, 5, and 6 begin to explore how online status modulates the motor resonance system using a variety of physiological and behavioural methods. Chapter 4 presents an experiment that examines how online status modulates motor cortical output as indexed by TMS-induced motor-evoked potentials (MEPs) during action observation in an undergraduate sample. We found that Instagram leaders showed reduced motor cortical output during action observation compared to Instagram followers. This finding is concordant with previous physiological work that suggests high status individuals are less socially attuned to the actions of others compared to low status individuals (Varnum et al., 2016). As such, the findings of this study are the first to suggest that online and offline (real-world) status may have concordant downstream physiological effects on social cognitive processing.

Chapter 5 presents a behavioural extension of the physiological study presented in Chapter 4. Specifically, Chapter 5 presents two experiments that examine how online status may modulate automatic imitation (a behavioural index of motor resonance) in an undergraduate sample. Across both experiments, we found that Instagram leaders exhibited less interference effect during the AIT compared to Instagram followers, at least when thoughts of their online status have recently been activated. This finding is concordant with the physiological work presented in Chapter 4, where participants with a high online status exhibited reduced motor cortical output during action observation compared to their low online status peers. As such, the findings presented in this chapter are the first to suggest that online and offline status may have concordant downstream behavioural effects on social cognitive processing.

Chapter 6 further extends on this line of research by examining how online status may modulate behavioural mimicry during a virtual interaction via ZOOM. We found that when undergraduate participants had a higher online status than the confederate, they exhibited significantly less mimicry behaviour during the interaction compared to participants that had a lower online status than the confederate. This finding extends on previous physiological work that has linked behavioural mimicry and motor resonance during action observation, and further supports that mimicry can be observed during an online interaction. In addition, these findings also suggest that online status can modulate behaviour beyond traditional laboratory-controlled conditions.

Finally, Chapter 7 concludes this dissertation by reviewing the important contributions and limitations of Chapters 2-6, exploring issues concerning automatic imitation and self-other distinction, and recommending future avenues of research.

Chapter 2

Socioeconomic Status and Self-Other Processing: Socioeconomic Status Predicts Interference in the Automatic Imitation Task

Farwaha, S., & Obhi, S. S. (2020). Socioeconomic status and self–other processing: Socioeconomic status predicts interference in the automatic imitation task. *Experimental Brain Research*, *238*(4), 833–841.

2.1 Preface

Previous physiological work by Varnum and colleagues (2016) has shown that high socioeconomic status (SES) undergraduates exhibit reduced interpersonal sensitivity during action observation compared to their low SES counterparts. The current chapter will focus on examining whether this finding can be extended behaviourally using the automatic imitation task. In addition, since most previous studies have traditionally used an undergraduate sample, we recruited adult participants from a range of neighbourhoods in the locale, in order to contribute meaningfully to the existing literature. Participants were classified as high or low SES based on their parental education, family income, and subjective status. Overall, we found that high SES individuals exhibited significantly less interference effect during the automatic imitation task compared to their low SES counterparts. This study is the first to examine differences in automatic imitation based on SES in adult participants from the local community. The implications of these results are discussed further in the chapter.

2.2 Abstract

High-status individuals have been found to be less attuned to the behaviour of others in the social environment, at least in the absence of any specific instructions to pay attention to them. Previous work using neural measures has shown that socioeconomic status (SES) influences the degree to which people are attuned to the actions of others. In particular, individuals from low-SES backgrounds were found to exhibit more mu-suppression, which has been suggested to reflect greater levels of sensorimotor resonance, compared to their high-SES counterparts. However, it is unclear whether such effects on brain activity translate into behaviour. Here, we examined differences in automatic imitation between high-SES and low-SES individuals. The automatic imitation task involves participants making actions in response to a numerical cue, while simultaneously being exposed to an action that is incongruent or congruent with the cued response. Patterns of interference effect reveal the extent to which the congruence of the observed action affects performance of the cued response. Interference thus indexes self–other processing, where high levels of interference suggest an increased susceptibility to the actions of others. Our results show that individuals from low-SES backgrounds exhibit more interference than individuals from high-SES backgrounds. Regression analyses revealed a negative relationship between SES and the degree of interference. Overall, our findings suggest that differences in SES

are linked to differences in self–other processing, which could be relevant for broader behavioural tendencies exhibited by individuals at varying levels of a social structure.

2.3 Introduction

In primates, there appears to be a positive correlation between neocortex size and the complexity of the social environment (Lewis, 2002; Dunbar & Shultz, 2007; Burkart, 2017). Within these environments, power is often used to create a hierarchical organization of the community in which those who are able to exert physical dominance over others, gain increased access to valuable resources (e.g. food, shelter, etc.) and potential mates than those who are less able to exert physical dominance (Chapais, 1991, 2015). The existence of hierarchy creates a dependence asymmetry, wherein the powerful, who are at the top of the hierarchy enjoy greater access to resources, and have disproportionate control over the social, economic, and physical outcomes of the powerless (Fiske, 2001; Keltner, Gruenfeld, & Anderson, 2003). This asymmetry is also associated with differences in how those with or without power process information about other individuals (Fiske, 1993; Smith & Trope, 2006; van Kleef et al., 2008).

The powerful experience fewer constraints in their daily lives and enjoy considerable control over their own outcomes (Galinsky et al., 2003). In contrast, powerless individuals encounter more constraints, in part because they depend more on the powerful for their own positive outcomes. As such, there also seems to exist a negative correlation between social power and goal pursuit (Guinote, 2007). Since the powerless seem to direct their attention to a variety of situational stimuli instead of their own goals, it has been found that they are more susceptible to irrelevant distractions (Guinote, 2007). As such, these types of distractions can lead to incorrect or delayed responses on various behavioural measures.

Over recent years, researchers have been probing how power affects key brain systems thought to be involved in social cognitive processes. For example, Hogeveen et al. (2014) used transcranial magnetic stimulation (TMS) to assess motor cortical excitability induced by the observation of another person's action. Their results were remarkable in that individuals who had been primed to a high-power mindset exhibited lower levels of motor cortical excitability than those who had been primed to a low-power mindset. Given the purported links between sensorimotor resonance and empathy, this pattern of data is consistent with previous psychological research showing that high power individuals pay less attention to others and exhibit lower levels of empathy toward others (e.g., Fiske & Berdahl, 2007; Van Kleef et al, 2008; de Guzman et al., 2016).

Similar work has been conducted examining the effects of status, and in particular socio-economic status and the activation of sensorimotor processes. Like power, status is also related to an individual's structural position. Specifically, it can yield control over social outcomes of value to others, through the degree to which respect and esteem are conferred on the status holder (Adler et al., 2000; Fiske & Berdahl, 2007). Recent work using electroencephalography (EEG) found that individuals scoring lower on measures of socio-economic status (SES) exhibited stronger EEG Mu-suppression during action observation (Varnum et al., 2016). Such findings support the idea that there seems to be an inverse relationship between power (and status) and motor resonance. Other recent work using EEG has also demonstrated that a high power mindset is linked to greater left frontal alpha asymmetry than a low power mindset, suggesting that high power individuals are more approach oriented than their lower power counterparts (Galang & Obhi, 2019).

Socioeconomic status (SES) has been operationalized as the combination of a person's resources, level of education, and subjective status (Ross & Mirowsky, 2008). Thus, SES can be determined based on specific objective information (e.g. family income, education, and occupation) and an individual's subjective sense of status. Differences in SES have been linked to individual differences in social information processing and empathy, with high SES individuals making less accurate judgements about the emotional states of others compared to their low SES counterparts (Kraus et al., 2010; Troy et al., 2017). Extant literature also suggests that there is a positive correlation between SES and narcissism (Piff, 2014). Given that status plays a significant role in our everyday interactions with others, understanding how our socioeconomic status might affect processes such as motor activity during action observation behaviourally is an important question (Destin et al., 2017)

Motor activation during action observation has been reliably measured using the automatic imitation task (AIT) (Brass et al., 2001). In this behavioural task, participants respond to on-screen numeric cues with index or middle finger actions. For example, if the numerical cue presented is a "1", participants are required to lift and re-press their index finger, and if the cue is a "2", they are required to lift and re-press their middle finger (Brass et al., 2001; Obhi et al, 2014). Importantly, while participants perform this task, they are also exposed to another on-screen hand performing similar index or middle finger actions (Heyes, 2011). One robust finding of the AIT is that participants tend to exhibit slower reaction times (RT) when the on-screen hand performs an action that is incongruent with the action prompted by the numeric cue (‘incongruent’ trial), compared to when the numeric cue and observed action both map onto the same required response (‘congruent’ trial; Brass et al., 2001; Obhi et al, 2014). The difference between congruent trial RT and incongruent trial RT is referred to as the interference effect, which is thought to be due to the automatic activation of the observed action (although there are also spatial compatibility effects) (Heyes, 2011). The interference effect has been found to be affected by a range of social moderator variables. For example, Obhi et al. (2014) found that there was a negative association between subclinical narcissism and the interference effect. More specifically, individuals high in subclinical narcissism were better able to supress automatic imitation compared to those lower in subclinical narcissism. Relatedly, Spengler et al. (2010) found that high self-focus was associated with less interference compared to a condition in which self-focus was not manipulated.

In the present investigation, we employed the automatic imitation task (AIT) to establish whether SES modulates the size of the interference effect (i.e., RT and error rate (ER) difference between incongruent and congruent trials). This is an important question, as previous work has found that SES affects mu-suppression (Varnum et al, 2016), but that work did not establish whether SES is associated with behaviourally significant differences in sensorimotor activity during action observation. The AIT allows for the assessment of behavioural effects. Based on previous work on the effects of power and status on motor resonance (e.g., Hogeveen et al, 2014; Varnum et al, 2016), we hypothesized that individuals with high SES would display less interference, indexed by RT and ER measures, in the automatic imitation task, compared to those with low SES. Finally, in contrast to some previous studies that have focused on a student population, we recruited participants from a range of neighbourhoods in the locale that were either low or high in average SES.

2.4 Methods

2.4.1 Participants

Fifty-eight volunteers (30 males, 28 females; M = 37.98 years, SD = 6.30) participated in this study for financial compensation. Participants were recruited from the local Hamilton population using poster advertisements. All participants were right-handed, had normal or corrected-to-normal vision, and were over 30 years of age. In addition, all participants were naïve with respect to the purpose of the experiment. The study was approved by the McMaster University Research Ethics Board (MREB) and participants provided informed consent before participation.

2.4.2 Stimuli

The experiment was programmed using Superlab v.4 (Cedrus, San Pedro, CA) and run on Windows 7 (Microsoft, Redmond, WA) with stimuli displayed on a 19-inch computer monitor. We employed the well-established automatic imitation task (AIT), as originally developed by Brass et al. (2001).

Each experimental trial consisted of a sequence of images, depicting various stages of a finger lift movement (index finger or middle finger). Specifically, the first image was of a hand in a resting position for 800, 1600, or 2400 ms. The subsequent second, third, and fourth images were of the various finger moving stages (see Figure 2.1). After each trial, a blue screen was displayed to signal the onset of the next trial.

For all trials, the on-screen hand was presented in the vertical orientation (with the fingers pointing to the right), whereas the participant rested their own hand in a horizontal orientation (fingers pointing to the computer monitor) on the computer keyboard. This feature of the design allows automatic imitation to be (somewhat) isolated from any potential spatial compatibility effects (Bach & Tipper, 2007; Gillmeister et al., 2008).

In total, the experiment contained 4 randomized blocks of 60 trials each. There were 15 repetitions of each trial type per block (congruent index finger trial, incongruent index finger trial, congruent middle finger trial, and incongruent middle finger trial). Participants were asked to lift and re-press the 'v' key with their index finger if a numeric cue of '1' appeared on the screen, and do the same with the 'b' key using their middle finger if a numeric cue of '2' appeared. The numeric cue (the 1 or 2) appeared between the index and middle fingers and marked the onset of the response period. For half of the trials, the stimulus depicted an action that was congruent with the participant's required movement (e.g. the cue was 2, and the stimulus showed a middle finger lift); on the other half of trials, the stimulus depicted an incongruent action (e.g. the cue was 2, but the stimulus showed an index finger lift).

2.4.3 Procedure

Participants completed the experiment in a testing room, while the researcher sat behind them to ensure they were following the instructions properly during the task. At the start of

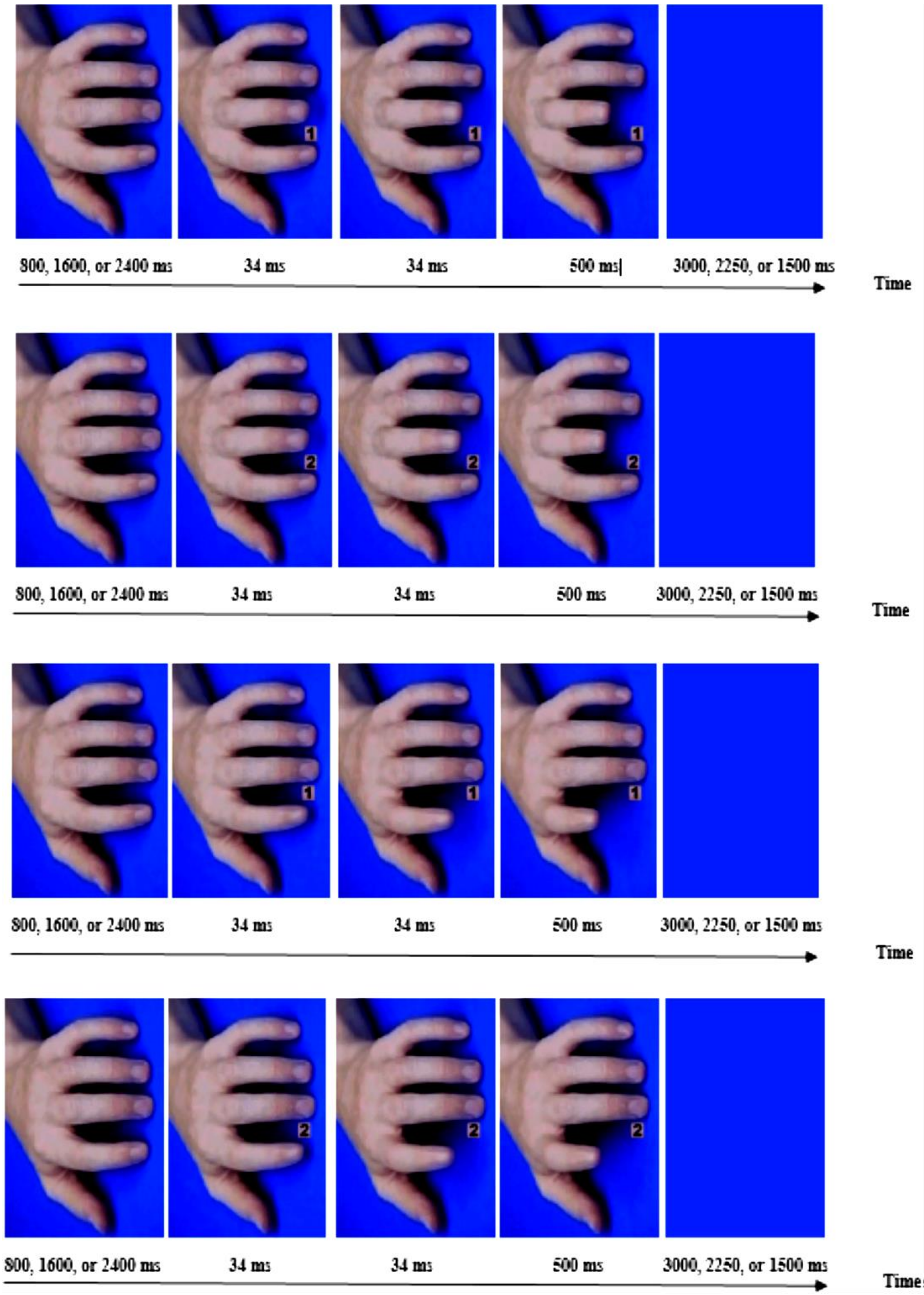


Figure 2.1 The five frames of the incongruent index finger, congruent middle finger, congruent index finger, and incongruent middle finger.

the experiment, the participants were informed that they would be holding down the 'v' and 'b' keys on the keyboard with their index and middle finger and would be responding to a '1' or '2' numerical cue that would appear on the screen. All participants were presented with a written version of these instructions on the computer screen and were also asked to complete a practice set of 8 trials before the actual experiment.

2.4.4 Socioeconomic Status Grouping

Importantly, before the participants began the practice trials for the AIT, participants were asked to complete the MacArthur Scale of Subjective Socioeconomic Status (SES), on which they were asked to indicate their subjective status relative to other Canadians by placing an 'X' on a ladder with ten rungs (Adler et al., 2000). They were also asked on six-point scales to indicate the level of their mother's and father's education (Varnum et al., 2016). In addition, they were asked to report their approximate family income on a ten-point scale (Varnum et al., 2016). Similar to the protocol of previous studies examining differences between low and high SES groups, a composite SES score was created for each participant by averaging the standardized values for their subjective SES, income, and highest parental education (Varnum et al., 2016). A file folder was made available to participants on their desk, where they were asked to place their completed forms. The experimenter made sure to leave the room while these questionnaires were administered and did not access this folder until after the experiment had concluded. This experimenter blind protocol minimized any potential biases arising from the experimenter knowing the participant's SES. Participants were classified as either high or low SES based on whether their composite SES score was above or below the mean of the samples.

2.5 Results

2.5.1 Data Analysis

Dependent measures in the experiment were reaction time (RT) and error rate (ER). To examine differences associated with varying levels of socioeconomic status, the sample was split into a low SES group and a high SES group based on their composite SES score.

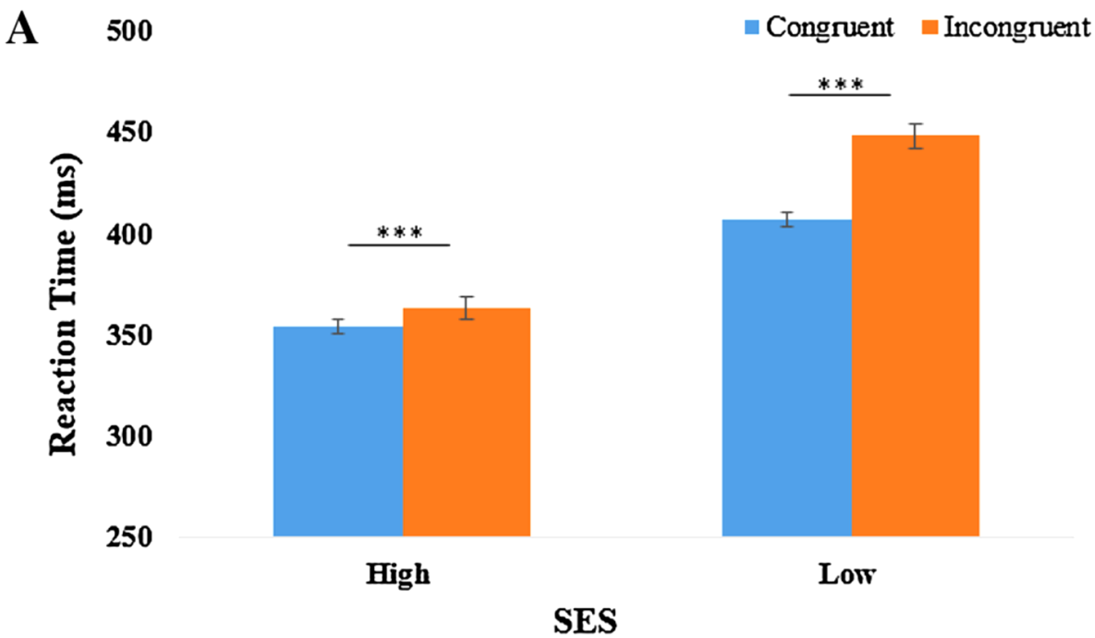
2.5.2 Range of SES

Our sample included participants from a wide range of social class backgrounds, ranging in subjective social status from 2 (near the bottom of the ladder) to 10 (near the top of the ladder; $M = 6.13$, SD = 2.79), ranging in highest parental education attainment from 1 (did not complete high school) to 6 (PhD, MD, or JD; $M = 3.70$, SD = 1.29), and ranging in annual family income from 1 (< $24,999) to 10 (≥ $225,000); $M = 4.36$, SD = 2.29).

2.5.3 Reaction Time (RT) Analysis: Comparing High SES and Low SES

Prior to conducting inferential statistical analysis, error-trials in which the participant lifted the incorrect finger were removed. In addition, response times that were more than 2.5 standard deviations above or below the mean for each condition (1.55% of congruent trials, 1.76% of incongruent trials) as well as trials without a recorded response, were removed. All assumptions for the statistical analysis were met. There were 29 individuals in the low-SES group and 29 individuals in the high-SES before the analyses were conducted.

For the RT analysis, a 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent, incongruent) and one between-subjects factor (SES group: high,



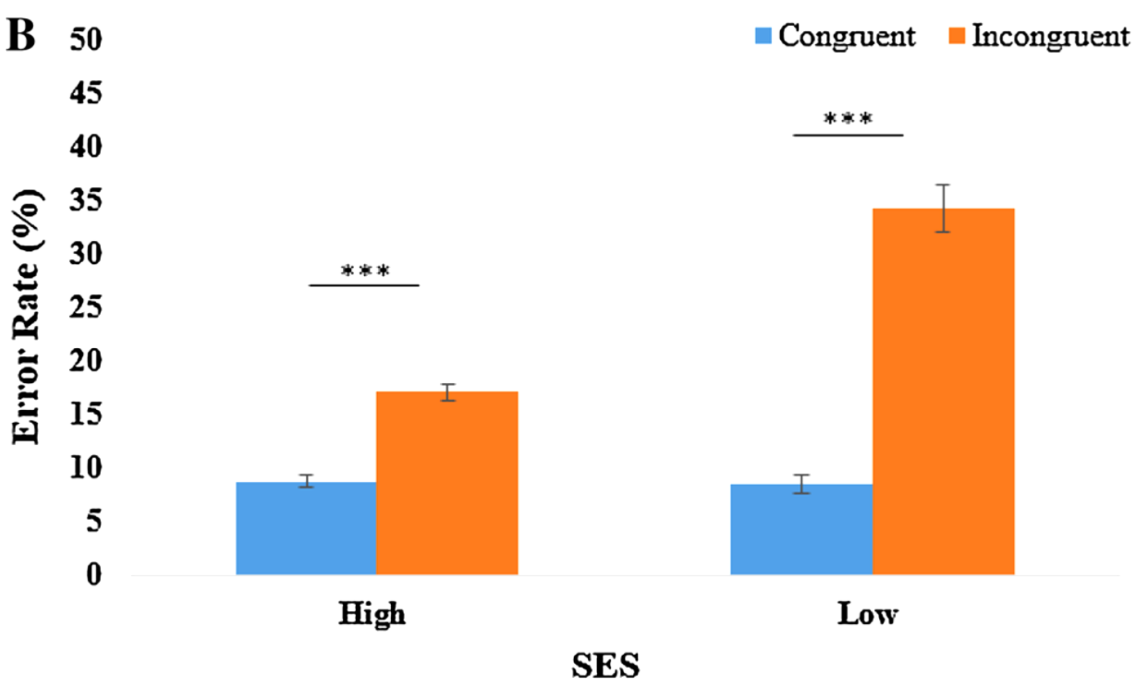


Figure 2.2 **a** There was a significant 2 × 2 Interaction between Congruence (RT) and SES. **b** There was also a significant 2 × 2 interaction between Congruence (ER) and SES. *Significant at α = 0.05, **significant at α = 0.01, ***significant at α = 0.001. Error bars indicate SEM.

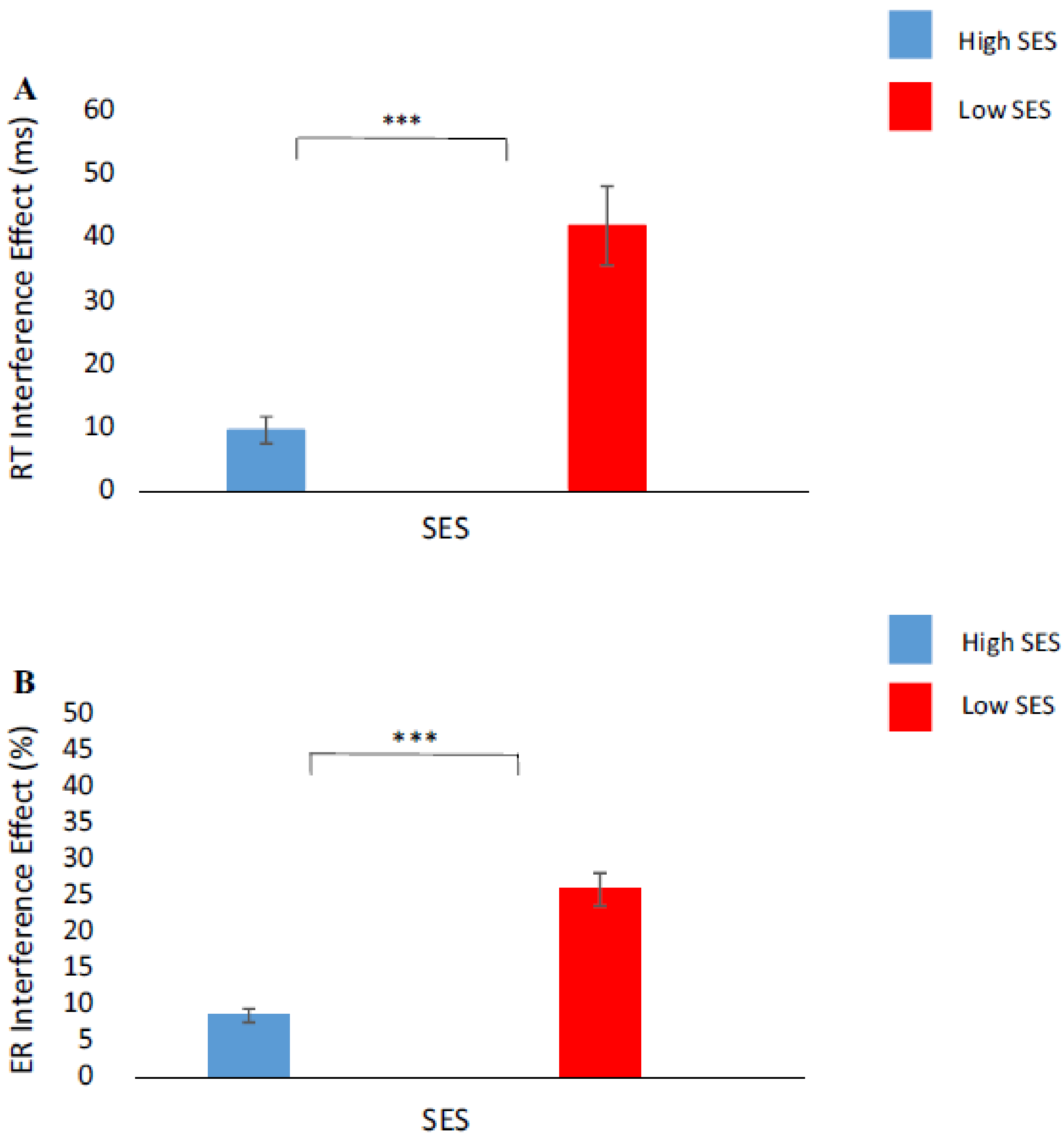


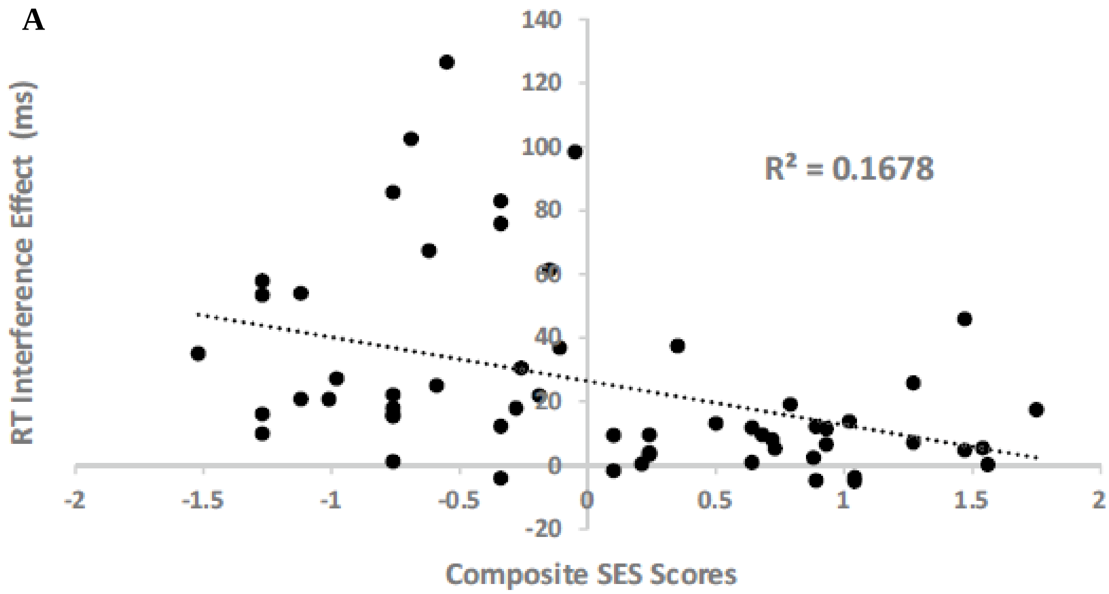
Figure 2.3 **a** The size of the RT interference effect (incongruent RT–congruent RT) was significantly higher for the low-SES group relative to the high-SES group. **b** The ER interference effect was also larger for the low-SES group compared to the high-SES group. *Significant at α = 0.05, **significant at α = 0.01, ***significant at α = 0.001. Error bars indicate SEM.

low) was conducted. This analysis revealed a significant main effect of congruence $F(1, 56) = 59.95$, $p < 0.001$, $\eta_p^2 = 0.517$, as well as a significant congruence by SES interaction, $F(1, 56) = 24.06$, $p < 0.001$, $\eta_p^2 = 0.301$ (See Figure 2.2a). Participants in both SES groups executed significantly faster responses on congruent trials (high: *M* = 354, SD = 19; low: *M* = 407, SD = 28) than on incongruent (high: *M* = 364, SD = 19; low: *M* = 449, SD = 32) trials [high: $t(28) = –4.36$, $p < 0.001$, $d = 0.52$; low: $t(28) = –6.68$, $p < 0.001$, $d = 1.39$]. Importantly though, the size of the RT interference effect (incongruent RT – congruent RT) was significantly higher for the low-SES group (*M* = 42, SD = 34) relative to the high-SES group (*M* = 9, SD = 12; $t(56) = 4.91$, $p < 0.001$, $d = 1.29$; See Figure 2.3a).

2.5.4 Error Rate (ER) Analysis: Comparing High SES and Low SES

For the ER analysis, a 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent, incongruent) and one between-subjects factor (SES group: high, low) was conducted. This analysis revealed a significant main effect of congruence, $F(1, 56) = 191.64$, $p < 0.001$, $\eta_p^2 = 0.774$, as well as a significant congruence by SES interaction, $F(1, 56) = 50.03$, $p < 0.001$, $\eta_p^2 = 0.472$ (See Figure 2.2b). Participants in both groups made fewer errors in congruent trials (high: *M* = 9%, SD = 3%; low: *M* = 9%, SD = 4%) compared to incongruent trials (high: *M* = 17%, SD = 5%; low: *M* = 34%, *SD* = 12%) [high: $t(28) = – 8.83$, $p < 0.001$, $d = 1.54$; low: $t(28) = – 11.32$, $p < 0.001$, $d = 2.43$]. Importantly though, the ER interference effect was larger in the low-SES group (*M* = 26%, SD = 12%) compared

A



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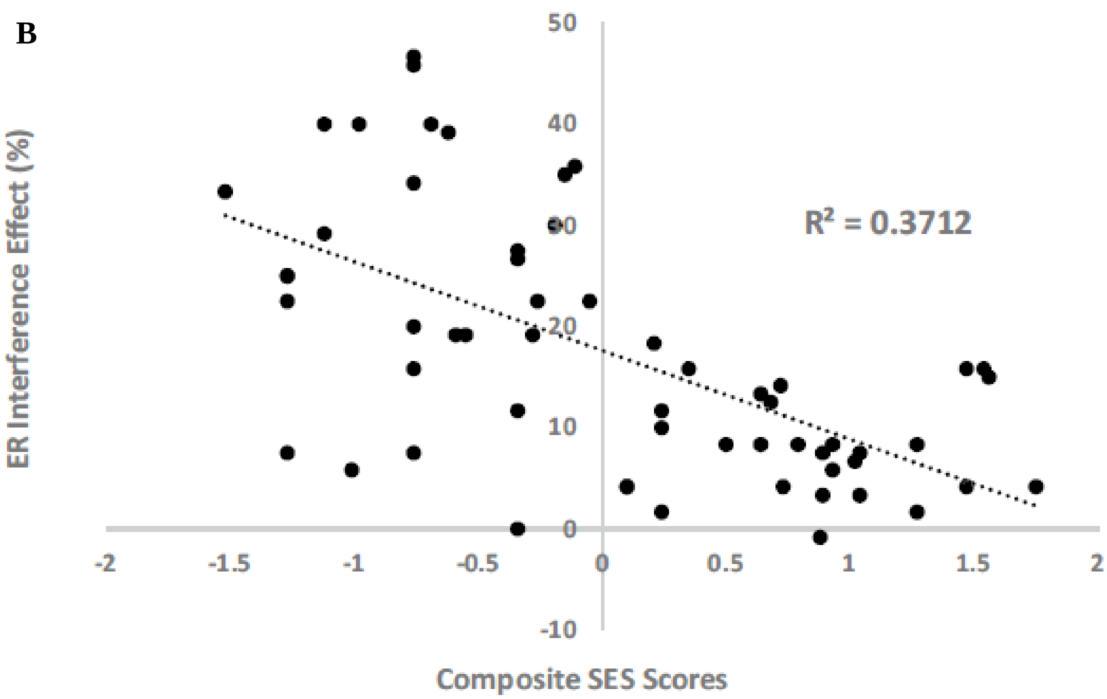


Figure 2.4 **a** There was a linear relationship between composite SES scores and automatic imitation, with higher composite SES scores significantly predicting the degree of RT interference (i.e., incongruent RT–congruent RT) and **b** ER interference (i.e., incongruent ER–congruent ER).

to the high-SES group (*M* = 8%, SD = 5%; $t(56) = 7.07$, $p < 0.001$, $d = 1.95$; See Figure 2.3b).

2.5.5 Regression Analyses

2.5.5.1 Relationship between SES and RT interference

In addition to our analysis dividing SES into low and high groups, we ran a regression analysis (i.e., treating composite SES scores as a continuous variable) to determine whether differences in SES predict differences in RT interference. SES significantly predicted RT interference, $\beta = -13.73$, $t(56) = -3.35$, $p = 0.001$, $R^2 = .168$ (See Figure 2.4).

2.5.5.2 Relationship between SES and ER interference

We ran a similar regression analysis (i.e., treating composite SES scores as a continuous variable) to determine whether differences in SES predicted differences in ER interference. The regression was also significant, $\beta = -8.78$, $t(56) = -5.75$, $p < 0.001$, $R^2 = 0.371$ (See Figure 2.4).

2.6 Discussion

The current study investigated whether socioeconomic status is related to performance in the AIT. Consistent with previous neurophysiological findings, our results showed that participants demonstrated a significant degree of automatic imitation, as indexed by interference effects for RT and ER (Heyes, 2011). Overall, and as expected, participants were faster and made fewer mistakes during congruent trials, compared to incongruent trials. More importantly, the high-SES group exhibited significantly less interference than the low-SES group. In other words, individuals of higher socioeconomic backgrounds were less prone to automatically imitate the on-screen hand compared to those with relatively lower socioeconomic backgrounds. Regression analyses demonstrated a significant negative relationship between SES and RT interference, and SES and ER interference. Thus, overall, our results confirm that differences in SES yield behaviourally significant effects. Extant literature suggests that the interference observed during the AIT may reflect the influence of action observation on the motor system of the observer (Heyes, 2011; Obhi et al., 2014). This result supports previous findings from cognitive neuroscience studies showing that increases in both power and socioeconomic status are associated with decreasing levels of motor resonance (Hogeveen et al., 2014; Varnum et al., 2016). The current behavioural study is the first (to our knowledge) to show that SES affects the degree to which automatic imitation occurs.

Motor resonance refers to the activation of one's motor system, when they observe another person perform an action (Aglioti et al., 2008; Hogeveen et al., 2014). Some research has suggested that motor resonance may be fundamental to our ability to process and resonate with the behaviour of others, however, direct evidence supporting these ideas is limited (Agnew et al., 2007; Pfeifer et al., 2008). With that said, the finding that one's brain tends to simulate the actions of others has been reliably confirmed in the literature (e.g., Waytz & Mitchell, 2011; Bernhardt & Singer, 2012). In the current study, we focus on motor resonance as a marker of the extent to which an individual is affected by the behaviour of another person.

It has been argued that the automatic imitation task, as used in the current study, provides an index of self-other control. That is, to prevent automatic imitation of an "other-generated" action, control over activated self-other representations is required. During the AIT, participants are required to respond to a numeric cue (which can be considered as a self-related process). During incongruent trials in the AIT, this self-related process is subject to interference from the influence of the 'other,' represented by the incongruent action stimulus (e.g., Obhi et al., 2014). Considered this way, the degree of interference can be taken as an index of the extent to which an individual is able to fulfil the "self" related process and override the influence of the concurrently activated "other" related process. In this light, our results demonstrate that such susceptibility to "other" activated processes is markedly reduced in those individuals with high socioeconomic status (SES) compared to those with low SES. Thus, in the language of "self-other" control, these individuals appear able to "assert" the self in a manner that is relatively unimpeded by the actions of another, compared to those who were lower in SES.

We suggest that differences in the interference effect between high- and low-SES individuals may have stemmed from differences in attentional processing of the stimuli. This assertion is based on previous work showing power related differences in attention (Guinote, 2007). Like power, status is related to an individual's structural position, in that it can yield control over social outcomes of value to others (Adler et al., 2000). Since low rank individuals are more dependent on others for favourable outcomes, we speculated that they may attend more to the social stimuli in the AIT (Fiske, 2001; Keltner et al., 2003). Other work has also shown that low-power individuals are generally more susceptible to attention capture by task irrelevant social stimuli during a task compared to high-power individuals (Guinote, 2007). These attentional differences may have led to the increased interference effect in low-SES individuals compared to their high-SES counterparts.

However, differences in attentional processing are not the only possible source of our results. It could be that the pattern of interference effects in high- and low-SES individuals were due to differences in the ability to inhibit task irrelevant actions during response-conflict. That is, high status individuals could simply be better at inhibiting task irrelevant action during incongruent trials, compared to their low status counterparts. Of course, these attentional and inhibition accounts may not be mutually exclusive, and both sets of processes could have contributed to our results. Future work is required to disentangle between these three possibilities. In addition, it is also important to note that other social and individual difference factors such as ethnicity, IQ, and a host of other traits were not taken into account in this study. It could be possible that variation in traits and social factors could contribute to different patterns of performance on the AIT. As such, researchers in the field are encouraged to follow up with this question through additional empirical studies.

The findings of this study are in line with previous research suggesting that one's social environment plays a significant role on their behaviour. Specifically, it has been found that individuals from high-SES backgrounds tend to focus on themselves more compared to their low-SES counterparts due to various discrepancies in their everyday experience (Kraus et al., 2012). It has been suggested that individuals from low-SES backgrounds tend to focus their attention more on others to cope with a lack of resources (Kraus et al., 2012). This is opposite to individuals in high-SES environments, who are encouraged to be more independent and less reliant on others (Kohn & Schooler, 1969).

The current results are also in line with recent physiological studies that have examined the influence of power and status on motor resonance using TMS and EEG. In one study, Hogeveen et al. (2014) found a reduction in motor-evoked potential facilitation in high power individuals relative to low power individuals. Given that various physiological studies have linked differences in motor resonance to these social factors, it is surprising that very few studies have extended such findings behaviourally. In another study, it was also found that lower SES individuals exhibited stronger Mu-suppression during action observation compared to high SES individuals (Varnum et al., 2016). However, there is still no consensus on whether Mu-suppression reliably indexes sensorimotor resonance during action observation (see Coll et al., 2015, 2017; Hobson & Bishop, 2016). Indeed, recent studies have found that Mu-suppression can be modulated by tactile stimulation, rather than manipulations of motor action (Coll et al., 2015, 2017). As such, mu-suppression during action observation may not be as reflective of sensorimotor resonance as previously thought. Thus, future work is encouraged to further validate the use and interpretation of Mu-suppression as an index of sensorimotor resonance.

In conclusion, we have shown that there is a negative association between an individual’s socioeconomic status and the interference they experience during the automatic imitation task. Given that interference in this task is thought to index motor resonance, our findings suggest that differences in socioeconomic status are linked to differences in the tendency to imitate the actions of another individual. Given that the degree of automatic imitation is thought to index self-other control processes, our results suggest that this control process is affected when individuals think about their SES. Importantly our data provide evidence of behaviourally significant effects of SES on imitative processing and thus go beyond previous physiological studies (Hogeveen et al, 2014; Varnum et al, 2016). Our work also opens up a new question about the effects of status (objective or subjective) on a host of other social cognitive processes. Increased understanding of any such differences could eventually aid in the development of interventions that help to reduce the disparity in social outcomes of individuals who differ in SES.

Chapter 3

The Effects of Socioeconomic Status and Situational Power on Self-Other Processing in the Automatic Imitation Task

Farwaha, S., & Obhi, S. S. (2021). The Effects of Socioeconomic Status and Situational Power on Self-Other Processing in the Automatic Imitation Task. *Experimental Brain Research*, 1–10.

3.1 Preface

The findings from the previous chapter corroborated the physiological work conducted by Varnum and colleagues (2016) by showing that high SES participants exhibited reduced sensorimotor resonance during action observation compared to their low SES counterparts using the automatic imitation task. The current chapter extends this line of research by examining whether priming participants of low and high SES to varying levels of social power differentially modulates automatic imitation. Previous physiological work by Hogeveen and colleagues (2014) found that when individuals are primed to high power, they exhibited reduced motor resonance during action observation compared to those primed to low power. However, no previous work has examined whether there is an interaction between chronic socioeconomic status and primed social power on automatic imitation. Similar to the study presented in Chapter 2, participants in this study were recruited from the local community and were classified as high or low SES based on their parental education, family income, and subjective status. Participants were then primed to high or low social power using power priming essays. Overall, we found that priming participants of low and high SES to varying levels of social power did not differentially modulate automatic imitation. This study is the first to examine the potential interaction between SES and power and its effect on automatic imitation. The implications of these results are discussed further in the chapter.

3.2 Abstract

Previous work using physiological measures has shown that socioeconomic status and social power both influence the degree to which people are attuned to the actions of others. However, it is unclear whether such effects on brain activity translate into behaviourally significant outcomes. Here, we examined differences in automatic imitation between individuals varying in SES and power from the local community population. The automatic imitation task involves participants making actions in response to a symbolic cue while simultaneously being exposed to an action that is incongruent or congruent with the cued response. Patterns of interference in reaction time and error rate reveal the extent to which a person is susceptible to influence from the actions of others – what we refer to as "the degree of social attunement". We found that individuals from low SES backgrounds and those in the low power priming group exhibited more interference than individuals from high SES backgrounds and those in the high power priming group. However, we did not

observe an interaction between chronic status and the power group. We discuss our results in relation to broader behavioural patterns exhibited by individuals at varying levels of a social structure.

3.3 Introduction

Various power dynamics have been shown to play a role in sustaining social hierarchy within a community. This is especially true within the animal kingdom, where some animals physically dominate others in order to gain access to food and potential mates (Chapais, 1991, 2015). In humans, the individuals at the top of the social hierarchy often exert control over the socio-economic outcomes of the powerless (Fiske, 2001; Keltner et al., 2003). Think of an employee at a small company relying on their boss for a fair salary or even a big promotion. Since the powerless depend on the powerful for positive socio-economic outcomes (Galinsky et al., 2003), they cannot freely pursue their own goals without their attention being captured by irrelevant social stimuli (Guinote, 2007). This differs drastically from the powerful, who can access and exert control over their own valued outcomes with relatively fewer restrictions, resulting in greater goal pursuit (Guinote, 2007).

Interestingly, these differences between the powerful and powerless have also been associated with differences in how individuals "resonate" with the actions of others, as well as other social cognitive processes (Fiske, 1993; Smith & Trope, 2006; van Kleef et al., 2008; Farwaha & Obhi, 2020). In one particular study, Hogeveen et al. (2014) found that high power individuals exhibited lower levels of motor cortical excitability (elicited using transcranial magnetic stimulation) during action observation compared to their low power counterparts. Research has also linked differences in sensorimotor resonance to varying levels of social status. For example, Varnum and colleagues (2016) found that low socioeconomic status (SES) individuals exhibited greater sensorimotor resonance during action observation, as indexed by EEG Mu-suppression. Such findings support the idea that both status and power may have similar effects on sensorimotor resonance. Although status and power are technically different constructs, it is easy to appreciate how they are often related. Indeed, high status individuals are often in a position to exert control over another's valued social outcomes – that is, they often have power. For example, if one is accepted or liked by a high status other, this may lead to positive future outcomes for them (respect from their peers, acceptance into groups, etc.) (Adler et al., 2000; Fiske & Berdahl, 2007). In the extant literature, SES has been operationalized as the combination of one's education, income, and subjective status (Ross & Mirowsky, 2008). Given that both power and status play a significant role in social life, examining how chronic SES and situational power may interact and influence sensorimotor resonance is an important question.

A frequently used behavioural index of sensorimotor resonance during action observation can be obtained using the Automatic Imitation Task (AIT) (Brass et al., 2001). In this behavioural task, participants make key responses to on-screen numerical cues, while an on-screen hand makes congruent or incongruent actions (Heyes, 2011). Research has consistently shown that participants are faster and more accurate in their responses during congruent trials versus incongruent trials (Brass et al., 2001; Obhi et al, 2014). The difference in reaction time and accuracy between both trial types is referred to as the interference effect, which is thought to reflect conflict between the participant's intended response (based on the numerical cue) and the motor representation activated within them by the on-screen hand action. To reduce the interference effect, one must be able to execute their own "self" related action and minimize any influence from the simultaneously activated "other" related motor representation during incongruent trials (Farwaha & Obhi, 2020). Thus, successful task performance depends on proficient self-other control. Greater interference has been found in individuals with lower SES (Farwaha & Obhi, 2020), lower sub-clinical narcissism (Obhi et al., 2014), and with lower self-focus (Spengler et al., 2010).

In the present investigation, the AIT was used to establish how situational power and chronic SES may interact and influence the size of the interference effect in both reaction time and accuracy. This is an important question, as previous physiological work (across separate experiments) has found that differences in SES and primed power influence sensorimotor resonance (Hogeveen et al., 2014; Varnum et al, 2016). Based on this previous work, we hypothesized that we would observe main effects of SES and power such that individuals with high SES would show less interference than individuals with low SES, and individuals with high power would show less interference than individuals with low power. We further expected to observe an interaction between SES and power, and thus we predicted that placing low SES individuals into a high power condition would reduce interference compared to when low SES participants were placed into a low power group. We also predicted that placing high SES individuals into a low power condition would increase interference. To increase the ecological validity of our study, we recruited participants from high and low SES neighbourhoods in the local community as opposed to

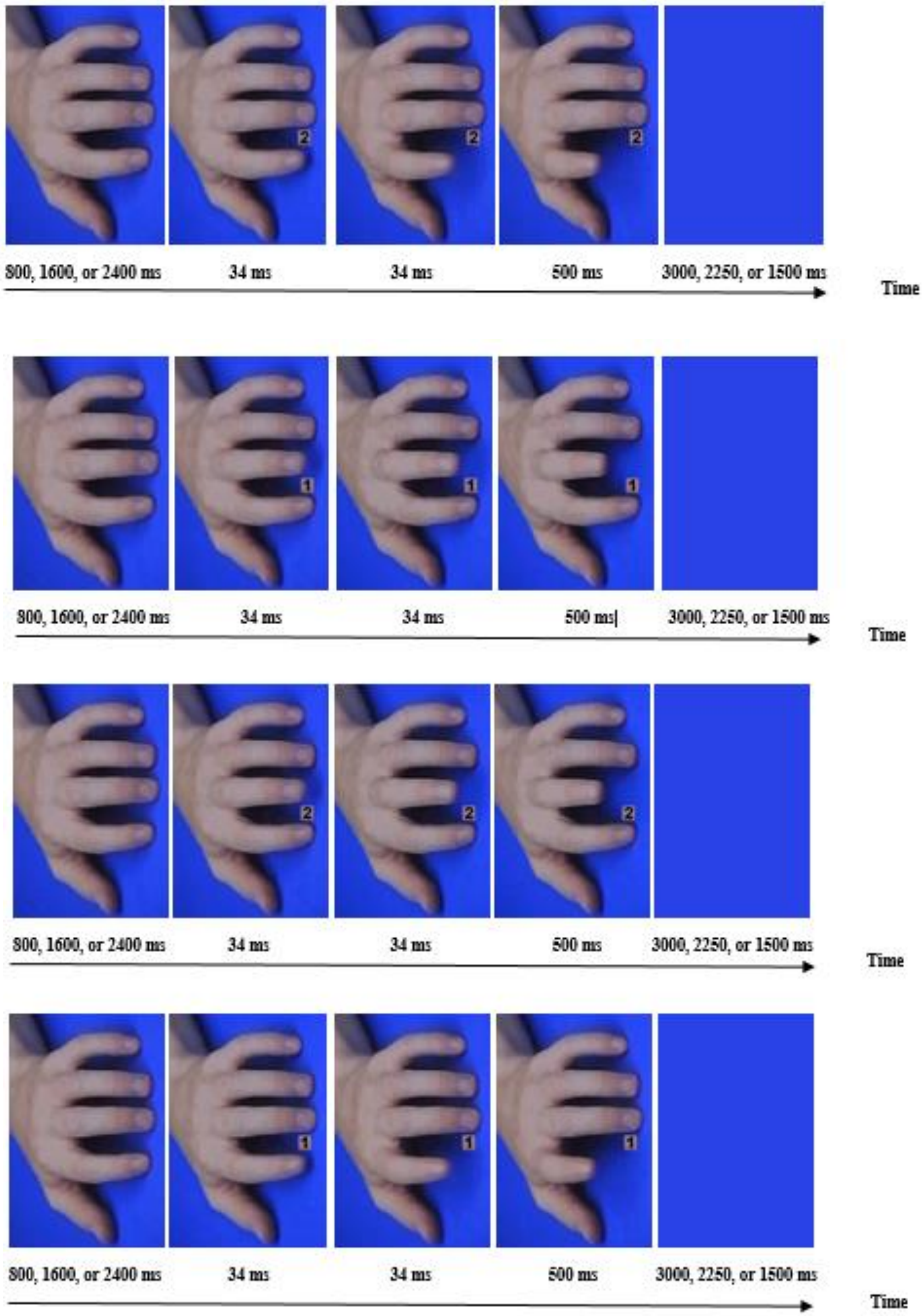


Figure 3.1 Image of an incongruent index finger lift, congruent middle finger lift, congruent index finger lift, and incongruent middle finger lift.

the university population. This is a significant step in the research on power and status, as much previous research has focused on university student samples (see Henrich et al, 2010 for an extended discussion of the limitations of this approach).

3.4 Methods

3.4.1 Participants

Eighty volunteers (42 males, 38 females; Mean age = 38.17 years, SD = 6.12) from Hamilton, Ontario participated in this study for compensation. To participate in this study, participants had to be right-handed, have normal vision (or corrected to normal), and be over 30 years of age. The study was approved by the McMaster University Research Ethics Board (MREB) and participants provided informed consent before participation.

3.4.2 Stimuli

In this experiment, participants were required to complete the automatic imitation task (AIT), which was programmed using Superlab (V.4) and displayed on a 19-inch computer monitor. Each experimental trial of the AIT depicted various stages of an index or middle finger lift movement (see Figure 3.1). The on-screen hand was presented in the vertical orientation, while participants responded in the horizontal orientation using a computer keyboard, to reduce any potential spatial compatibility effects (Bach & Tipper, 2007; Gillmeister et al., 2008; Farwaha & Obhi, 2020).

In total, the experiment contained 4 randomized blocks of 60 trials each. There were a total of 4 different trial types; there were two congruent and two incongruent trials each containing index or middle finger movements respectively. Participants were asked to respond when they saw a numeric cue appear between the index and middle finger.

3.4.3 Procedure

All participants completed the AIT in a testing cubicle study room alongside a researcher who ensured that they were following instructions correctly. At the start of the task, participants were given both verbal and written instructions which required them to make responses using the keyboard in front of them to on-screen numerical cues. Specifically, they were told to make their responses using both the 'v' (index finger) and 'b' (middle finger) keys on the keyboard. They were informed that they would need to lift and re-press either key based on the number presented. If they saw a '1', they were told to lift and re-press their index finger, and if they saw a '2', they were asked to lift and re-press their middle finger. Participants completed 8 practice trials before the experimental trials.

3.4.4 Socioeconomic Status and Social Power Grouping

Before completing the AIT, participants were asked to complete the MacArthur Scale of Subjective Socioeconomic Status (SES), on which their subjective status was measured relative to other Canadians using a 10-rung ladder (Adler et al., 2000; Farwaha & Obhi, 2020). Using an additional demographic survey, participants were also asked to provide information regarding their maternal and paternal education levels using a 6-point scale and family income on a 10-point scale (Varnum et al., 2016; Farwaha & Obhi, 2020). When completed, participants were asked to place the surveys in a file folder made available to them on their desk. The experimenter left the room while these surveys were being completed and did not access them until the experiment was finished, to reduce any potential biases from knowing the SES of the participant. After completing these surveys, participants were also asked to write an essay using the computer before beginning the AIT. Importantly, the experimenter was blind to the power conditions (high power or low power) that participants were randomly assigned to during the study. In the low power condition, participants were asked to write about an experience where another person had power over them. In the high power condition, they were asked to write about an experience where they had power over another person. Power priming has been shown to lead to differences in conforming to another's behaviour (Galinsky et al., 2006), sense of agency (Obhi et al., 2012), and even motor resonance (Hogeveen, et al., 2014; Varnum et al, 2016). As such, we maintain that power priming essays are sufficient to manipulate social power in participants before they completed the AIT.

3.5 Results

3.5.1 Data Coding and Analysis

Dependent measures in the experiment were reaction time (RT) and error rate (ER). In addition, the difference between RT/ER incongruent and congruent conditions was used to examine group differences in interference. Trials in which the participant made an incorrect finger lift or had no recorded response were removed prior to conducting statistical analysis (< 3% of total trials). In addition, response times that were more than 3 standard deviations above or below the mean for each condition were also excluded (1.20% of congruent trials, 1.42% of incongruent trials).

The experiment comprised a 2 (SES: low, high) x 2 (Power: low, high) x 2 (Congruence: congruent, incongruent) mixed design with the following 4 groups: low SES/high power group, low SES/low power group, high SES/high power group, and high SES/low power group based on their composite SES score and power condition. Since our primary interest was to examine whether the effect of SES on automatic imitation was influenced by situational power priming, a three-way mixed model ANOVA was used to examine any main effects and interactions. A significant amount of previous work on automatic imitation has used repeated measures and mixed model ANOVAs to examine group differences on the automatic imitation task (Heyes et al., 2005; Hogeveen & Obhi, 2013; Ainley et al., 2014; Maister and Tsakiris, 2016). Furthermore, linear regression analyses were used to examine how SES (using composite SES scores as a continuous variable) and aggregate power scores predict differences in the interference effect during the AIT.

In regard to SES, a similar protocol to the one used by Varnum et al. (2016) and Farwaha and Obhi (2020) was used for this study, which involved creating a composite SES score by averaging the standardized values for their subjective SES, income, and highest parental education. High and low SES groups were created based on whether their composite score was above or below the mean of the samples.

In regard to the power essay manipulation, a similar protocol to the one used by Hogeveen et al. (2014) was adopted for this study. More specifically, we had two independent essay coders, who were blind to the purposes of the study, rate each power priming essay for power, emotional valence, and action on a 7-point scale. Each coder was given the following instructions per essay: (1) how much power did the participant have in the essay from -3 (least power) to +3 (most power)?, (2) how powerful was their description of emotion in the essay from -3 (most negative valence) to +3 (most positive valence)?, and (3) what amount of action is described in the essay from 1 (least action) to 7 (most action). The amount of action described in each essay was examined to ensure that potential differences in the AIT responses were not facilitated by differences in motoric memory (Hogeveen et al., 2014). Average aggregate scores for each criteria (power, emotional valence, and action) were only used if their respective inter-rater correlations were statistically significant. Overall, there were 20 individuals in each group (low SES/low power, low SES/high power, high SES/low power, high SES/high power) before the analyses were conducted. All assumptions for the statistical analysis were met.

3.5.2 Range of SES

Our sample's social status backgrounds ranged in subjective social status from 1 (near the bottom of the ladder) to 10 (near the top of the ladder; $M = 5.20$, SD = 2.02). Their highest parental education attainment ranged from 1 (did not complete high school) to 6 (PhD, MD, or JD; $M = 4.25$, SD = 1.31), and their annual family income ranged from 1 (< \$24,999) to 10 (≥ \$225,000); $M = 4.56$, SD = 1.85).

3.5.3 Rating Power, Valence and Action in the Essays

The independent raters provided reliable judgements of power (r = 0.69, p < 0.001) and emotional valence (r = 0.53, p < 0.001). As such, aggregate power and emotional valence scores were created for the purposes of statistical analysis. Independent sample t tests were used to examine differences in aggregate power and emotional valence essay scores across the power priming conditions. Aggregate power scores in the high power condition (M = 1.40, SD = 0.93) were significantly higher than the low power condition (M = - 1.48, SD = 0.89), $t(78)$ = 14.1, p < 0.001, d = 3.16. Similarly, aggregate emotional valence scores in the high power condition (M = 0.45, SD = 1.38) were significantly higher than the low power condition (M = - 1.80, SD = 0.81), $t(78)$ = 8.92, p < 0.001, d = 1.99. Our results indicate that individuals in the high power condition wrote essays that were significantly more positive (in terms of affect) and more powerful compared to individuals in the low power condition. This result fits well with previous literature that has found an association between positive affect and high power (Keltner et al., 2003). Furthermore, to control for the influence of motor-related memory on automatic imitation, independent raters also provided judgements on the amount of action that was described in each essay. Since their ratings were significantly correlated (r = 0.31, p < 0.01), aggregate scores for action were created for the purposes of statistical analysis. Independent sample t tests were used to examine differences in aggregate action essay scores across the power priming condition. Importantly, we did not find a significant difference in aggregate action scores between the high power (M = 3.17, SD = 1.23) and low power (M = 2.76, SD = 1.03) power priming conditions, $t(78)$ = 1.63, p = 0.108.

Descriptives

	SES	Power	Congruent RT	Incongruent RT
Mean	L	H	364	404
		L	371	415
	H	H	360	372
		L	367	398
Std. error mean	L	H	9	11
		L	8	11
	H	H	11	12
		L	14	16
Standard deviation	L	H	41	50
		L	38	50
	H	H	48	54
		L	61	70

Table 3.2 Means, standard error of the means, and standard deviations for reaction time (ms) of all groups across trial type.

3.5.4 Reaction Time (RT) Analysis: SES and Power

Mean RT data for congruent and incongruent conditions across all groups are presented in table 3.2 and summary statistics for the SES group are presented in Table 3.3. For the RT analysis, a 2 x 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent, incongruent) and two between-subject factors (SES group: high, low; Power group: high, low) was conducted. There was a significant main effect of congruence, $F(1, 76) = 172.47$, $p < 0.001$, $\eta_p^2 = 0.694$, a significant congruence by SES interaction, $F(1, 76)$

= 17.71, $p < 0.001$, $\eta_p^2 = 0.189$, as well as a significant congruence by power interaction, $F(1, 76) = 5.17$, $p < 0.05$, $\eta_p^2 = 0.064$. There was no significant three-way interaction (p = 0.144). These interactions show that automatic imitation differed between high and low SES and high and low power, respectively (see RT data in Figure 3.4). Importantly, the size of the RT interference effect (incongruent RT – congruent RT) was significantly higher for the low SES group (*M* = 42 ms, *SD* = 19 ms) relative to the high SES group (*M* = 22 ms, *SD* = 25 ms; $t(78) = 4.07$, $p < 0.001$, $d = 0.910$ (See Figure 3.5A). Similarly, the size of the RT interference effect was significantly higher for the low power group (*M* = 37 ms, *SD* = 25 ms) relative to the high power group (*M* = 26 ms, *SD* = 23 ms; $t(78) = 2.05$, $p < 0.05$, d = 0.459 (See Figure 3.5B).

Descriptives

	SES	Congruent RT	Incongruent RT	Congruent ER	Incongruent ER
Mean	H	364	385	7.23	19.1
	L	368	409	3.87	12.3
Std. error mean	H	8.52	9.93	0.724	1.92
	L	6.20	7.80	0.608	1.23
Standard deviation	H	53.9	62.8	4.58	12.1
	L	39.2	49.3	3.84	7.78

Table 3.3 Means, standard error of the means, and standard deviations for reaction time (ms) and error rate (%) of the SES group.

An additional exploratory analysis was conducted to examine any potential differences in RT interference effect between high status and high power groups, as well as, low status and low power groups, respectively. This analysis revealed that there was no significant difference between high status (*M* = 22 ms, *SD* = 25 ms) and high power (*M* = 26 ms, *SD* = 23 ms) on the size of the interference effect, $t(78) = -0.866$, $p = 0.389$. Similarly, there was no significant difference between low status (*M* = 42 ms, *SD* = 19 ms) and low power (*M* = 37 ms, *SD* = 25 ms) on the size of the interference effect, $t(78) = 0.943$, $p = 0.349$. As such, it appears that there are no differential effects of status and power on RT interference effect during the AIT task.

3.5.5 Error Rate (ER) Analysis: SES and Power

For the ER analysis, a 2 x 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent, incongruent) and two between-subject factors (SES group: high, low; Power group: high, low) was conducted. There was a significant main effect of congruence, $F(1, 76) = 109.89$, $p < 0.001$, $\eta_p^2 = 0.591$. However, this analysis did not reveal a significant three-way interaction ($p = 0.097$), significant interaction between SES and congruence ($p = 0.085$), or significant interaction between power and congruence ($p = 0.216$).

3.5.6 Regression Analyses

3.5.6.1 Relationship between SES and RT interference

Using composite SES scores as a continuous variable, we ran a regression analysis to

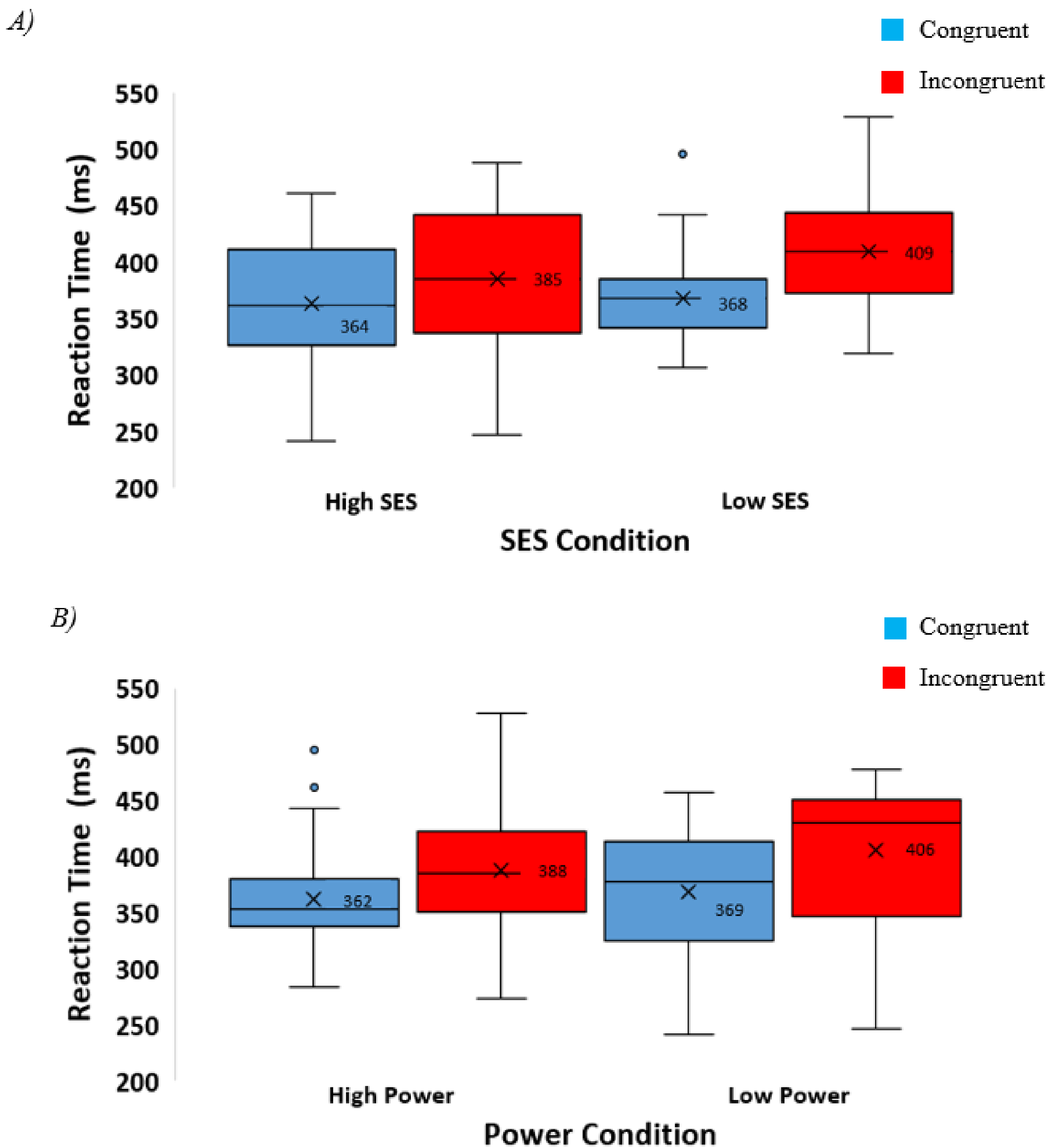
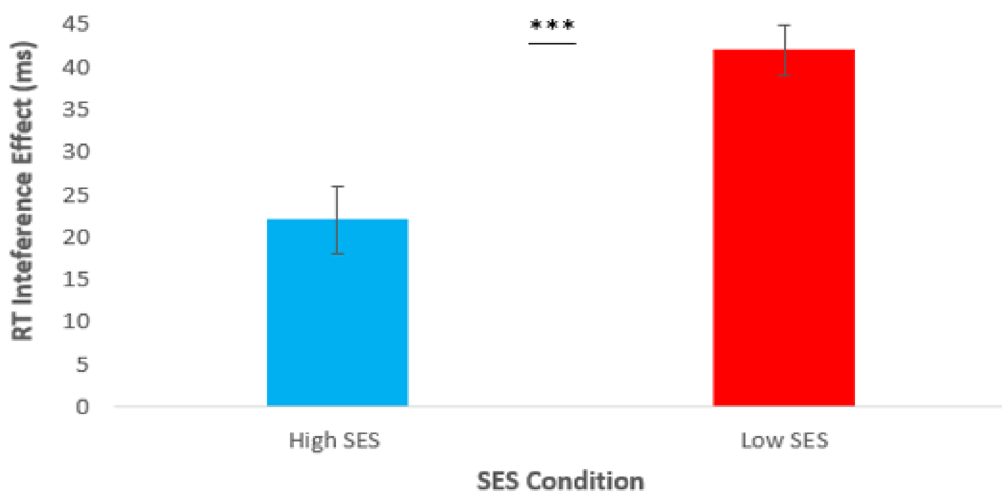


Figure 3.4 (A) Reaction times for the high and low SES groups during congruent and incongruent trials. (B) Reaction times for the high and low power groups during congruent and incongruent trials.

A)



B)

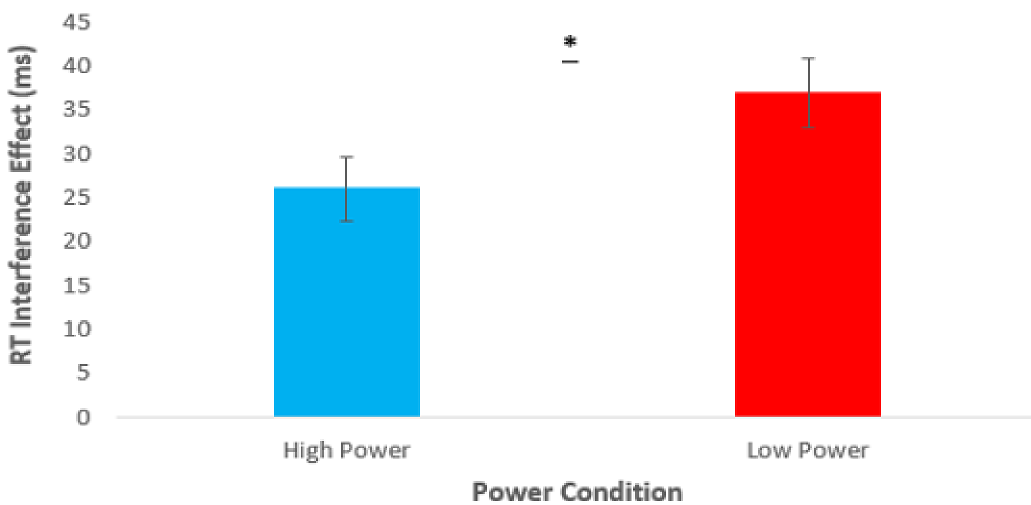


Figure 3.5 (A) Size of the RT interference effect was significantly higher for the low SES group relative to the high SES group. (B) Size of the RT interference effect was significantly higher for the low power group relative to the high power group. Error bars indicate SEM. *Significant at 0.05, **Significant at 0.01, ***Significant at 0.001.

determine whether differences in SES predicted differences in RT interference. This regression analysis was significant, $\beta = -14.2$, $t(78) = -4.64$, $p < 0.001$, $R^2 = 0.216$ (see Fig. 3.6).

3.5.6.2 Relationship between Power and RT interference

We also ran a regression analysis to determine whether differences in aggregate power essay scores predicted differences in RT interference. Aggregate power essay scores did not significantly predict RT interference ($p = 0.076$).

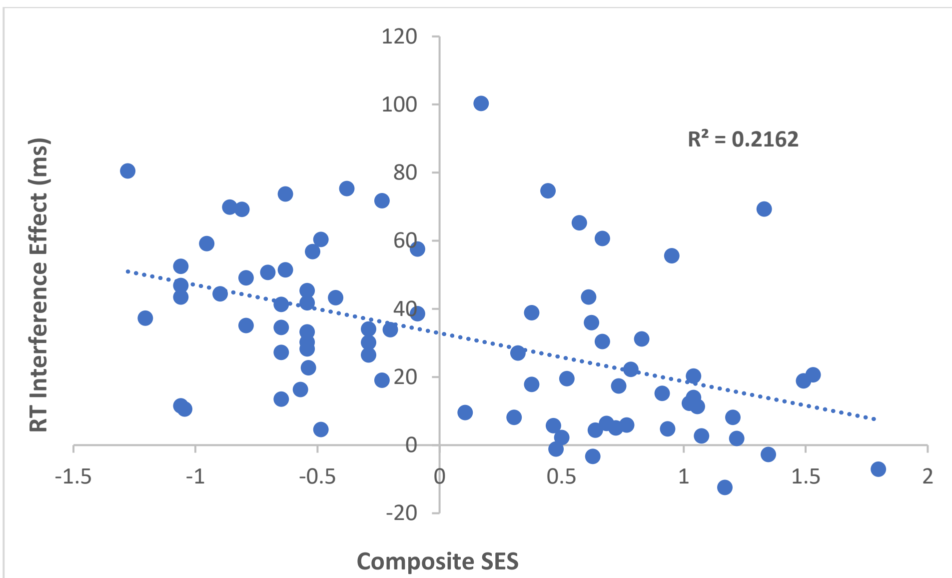


Figure 3.6 There was a linear relationship between composite SES scores and RT interference effect.

3.6 Discussion

The primary focus of this paper was to examine potential differences in automatic imitation in individuals of varying levels of SES and situational power and to determine whether and how chronic SES and situational power interact. To our knowledge, this is the first behavioural study looking at imitative processing in relation to both SES and power. Our findings indicate that priming participants of low and high SES to varying levels of social power did not differentially modulate automatic imitation. Indeed, we found that individuals generally exhibited faster reaction time and better accuracy during congruent trials compared to incongruent trials on the automatic imitation task. However, we did not observe an interaction between chronic socioeconomic status and primed social power on automatic imitation. Instead, as revealed by further exploratory analyses, we found that individuals of both high and low SES and power performed similarly on the automatic imitation task. Specifically, there were no significant differences in RT interference effect between high status and high power groups, or low status and low power groups, respectively. Overall, it was found that individuals with both high SES and power (respectively) exhibited a smaller interference effect compared to their low SES and power counterparts. These results are consistent with the findings of previous physiological studies examining the effects of status and power on sensorimotor resonance (Hogeveen et al., 2014; Varnum et al., 2016).

There are several potential explanations for these results. First, it could be that chronic SES overshadows any effects of power priming. Thus, reminding one of a memory where they had power over another individual or vice versa, may not have been sufficient to override the effect of everyday experiences of chronic SES – that is, high and low SES individuals may have been at floor and ceiling levels of interference already such that additional power priming had no effect. This possibility is also supported by our regression analyses which showed that composite SES scores predicted differences in RT interference, while aggregate power scores did not. Second, it could also be the case that the essay writing technique we used for priming different levels of social power was not sufficient to induce different power states in our participants – although much previous work has used this approach to study power and has yielded predicted patterns of effects on a range of measures. That said, even though previous work has supported the link between power priming and differences in a range of social cognitive measures (Goodwin et al., 2000; Schmid-Mast et al., 2009; Joshi & Fast, 2013; Hogeveen et al., 2014; Galang & Obhi, 2019), more work may be needed to ensure that this priming technique is adequate for manipulating social power across the full range of possible tasks. Finally, it is also possible that the automatic imitation task may not be sensitive enough to capture a power by SES interaction behaviourally. As such, it will be important for future work examining the relationship between chronic SES and situational power to use physiological methods such as TMS motor-evoked potentials (Hogeveen et al., 2014) or EEG mu-suppression (Varnum et al., 2016), to establish whether there are any SES x power interactive effects on sensorimotor resonance.

A possible explanation for the difference between high SES/power and low SES/power may be linked to differential attentional processing of social information. Indeed, previous work has suggested that since high rank individuals are in a position to control the social, physical, and economic outcomes of others, they are afforded the opportunity to focus their attention on their own goals (Guinote, 2007). However, this may not be the case for low rank individuals, as they rely more on others for access to these positive outcomes and as a result, focus their attention more on others instead of their own goals (Guinote, 2007). This may also explain the differences we observe between high SES/power and low SES/power individuals. In society, individuals with high rank control the valued social outcomes of others (Adler et al., 2000). People generally want to be liked by high rank individuals, so that they can have access to more favourable social outcomes themselves. Recent work has also found that individuals from high status backgrounds are more self-focused compared to low status individuals due to differences in upbringing (Kraus et al., 2012). The latter may have faced more obstacles including potential threats in their social environment or a lack of resources. As such, they may have had to be more dependent or attentive to others to survive (Kraus et al., 2012). In this way, low status individuals may be naturally more other-focused compared to their high status counterparts (Fiske, 2001; Keltner et al., 2003). Furthermore, in the context of self-other control, our findings suggest that individuals in both high SES and high power groups are less vulnerable to these "other" activated processes compared to their low SES and low power counterparts.

Although this study is the first to our knowledge to examine how the interaction between SES and power may modulate automatic imitation in a community sample, there are several limitations that must be addressed. First, we did not account for differences in other variables (IQ, time spent using a computer, race, sex, personal level of education etc.) that may have influenced automatic imitation. As such, future studies should also examine how these variables may play a role in modulating performance on this task. Second, this study relied solely on using power priming essays to manipulate situational power. Future work should explore the effects of other power priming techniques that could be applied to manipulate situational power, such as assigning participants to "teacher" or "student" roles (during a role-play task) before they completed the AIT (Joshi & Fast, 2013). Future studies examining the influence of social factors on the AIT should also examine whether the imitative effects observed are specific only to social cues or whether they would also be observed during a general inhibitory control task involving response conflict, such as the Stroop task. Furthermore, it is also important for future studies to investigate whether our effect depends on priming SES before the task or whether it would manifest without priming. Indeed, it is quite possible that in the real world, individual's may experience plenty of reminders (that could act as primes) about their relative SES compared to others around them.

In conclusion, we observed significant effects of both SES and power on interference during the automatic imitation task, but we did not observe any interactions between SES and social power. This work therefore confirms previous research on SES and power and adds an important ecologically valid extension to this work by using a community sample as opposed to a sample of university students. Our work also highlights the importance of understanding how chronic SES and situational power may interact with each other to influence (or not influence) social perception, cognition, and behaviour beyond automatic imitation. It remains for future work to address these intriguing and outstanding questions.

Chapter 4

Differential Motor Facilitation During Action Observation in Followers and Leaders on Instagram

Farwaha, S., & Obhi, S. S. (2019). Differential motor facilitation during action observation in followers and leaders on Instagram. *Frontiers in Human Neuroscience, 13*, 8.

4.1 Preface

Previous physiological work has shown that high power and high SES participants exhibit reduced motor resonance during action observation compared to their low power and low SES counterparts (Hogeveen, et al., 2014; Varnum et al., 2016). Even though these studies have examined how real-world social hierarchies modulate motor resonance during action observation, they have not considered the influence of online social hierarchies on this system. As such, an important question is whether online status has similar downstream effects on motor resonance compared to previously documented effects of offline (real-world) status. In this chapter, we begin to explore the social hierarchy on Instagram and examine whether there are differences in motor cortical output during action observation between leaders and followers on the platform. Overall, we found that Instagram followers exhibited increased motor-evoked potential (MEP) facilitation during action observation compared to leaders. This is the first study to examine the influence of online status on motor cortical output. The implications of the findings are discussed further in the chapter.

4.2 Abstract

High power and high socioeconomic status individuals have been found to exhibit less motor system activity during observation of another individual's behaviour. In the modern world, the use of online social networks for social interaction is increasing, and these social networks afford new forms of social status hierarchy. An important question is whether social status in an online setting affects social information processing in a way that resembles the known effects of real-world status on such processing. Using transcranial magnetic stimulation (TMS), we examined differences in motor cortical output during action observation between Instagram "leaders" and "followers". Instagram Leaders were defined as individuals who have more followers than they are following, while Instagram Followers were defined as individuals who have fewer followers than they follow. We found that Followers exhibited increased Motor-evoked Potential (MEP) facilitation during action observation compared to Leaders. Correlational analyses also revealed a positive association between an individual's Instagram follower/following ratio and their perceived sense of online status. Overall, the findings of this study provide some evidence in favour of the idea that our online sense of status and offline sense of status might be concordant in terms of their effect on motor cortical output during action observation.

4.3 Introduction

Social interaction has traditionally taken place in a face-to-face setting between people who share the same physical space (Mathes, 1978; Baumeister & Leary, 1995). Within groups of people interacting in these settings, status hierarchies exist between individuals who are relatively high in status and those who are relatively low in status. As a result, there is a discrepancy between the associated thoughts and behaviours of those at various points within this hierarchy (Erber & Fiske, 1984; Graf et al., 2012; Maner & Menzel, 2013; Keltner & Cordaro, 2017). Numerous studies have examined the effects of status and social power on social cognition, perception and behaviour (Fiske, 1993; Keltner et al., 2003; Smith & Trope, 2006; Guinote, 2007; van Kleef et al., 2008). It has been found that powerful individuals are significantly more goal oriented and devote less attention to less powerful others (Keltner et al., 2003) compared to individuals with a lower sense of social power (Ellyson & Dovidio, 1985; Fiske, 1993; Foerster et al., 2005; Fiske & Berdahl, 2007)[1]. Extant literature suggests that this dependence asymmetry between individuals of high and low status is linked with a host of effects on social information processing. However, very little is known about how social status in an online setting affects social information processing. One's status can be regarded as a composition of their level of respect and esteem in society. Specifically, it refers to where an individual ranks relative to others in society (Adler et al., 2000). In contemporary society, it is vital to address the changing dynamic of social interaction. The rise of the internet has allowed individuals to

[1]Status relates to power in that it often allows one to control the social outcomes of value to others. However, even though status and power are often considered together, it is important to note that they are separate constructs and can exert dissociable effects in certain cases.

partake in various forms of social interaction through the popular use of online social media. This new type of online interaction can take place in the form of instant messaging, commenting on a friend's uploaded content, or "liking" the pictures they post on the social media platform. Given the prevalence of social media as a method of social interaction, it is important to examine whether online and real-world social interactions depend on the same cognitive processes, and whether the online world and the real world are concordant in terms of their effect on social information processing.

In today's generation, individuals promote themselves and communicate with their peers primarily through the use of online social networks (Ridgway & Clayton, 2016). Currently, one of the most popular online social networks is Instagram (Sheldon & Bryant, 2016; Stapleton et al., 2017), which is used to share audio-visual content with "followers" (i.e. subscribers to their Instagram account). This social media application is often used on smart phones and provides users with several functions such as: 1) filtering their photos with the goal of attracting more likes, comments, and followers and 2) including keywords using hashtags (#), which relay the major themes of their post in the caption section (Lee et al., 2015). In this paper, we focus specifically on the nature of social interactions on Instagram and examine the ratio between the number of "followers" an individual has versus the number of others that they are "following", as a way to potentially index a form of Instagram status hierarchy. Extant literature suggests that those who have more followers than they are following on social media exhibit greater perceived online status and social power compared to those who have profiles with the opposite trend (DeSouza & Ferris, 2015; McCain & Campbell, 2016; Sherman et al., 2016). Therefore, we ask whether individuals who have more followers than they are following are similar to high status power holders in the real-world. Specifically, we focus on the previously demonstrated effects of status and power on interpersonal sensitivity, where the observation of an action leads to the automatic activation of neural circuits in the observer, as if they were performing the action themselves (Oberman & Ramachandran, 2007; Iacoboni, 2009; Obhi & Hogeveen, 2010; Rizzolatti & Sinigaglia, 2010; Heyes, 2010; Hogeveen & Obhi, 2011). This motor cortical activity during action observation has been widely reported and is thought to be an important mechanism for processing other social agents (Iacoboni & Dapretto, 2006; Hari & Kujala, 2009). In the current experiment, we ask whether social status hierarchy on Instagram is associated with effects on interpersonal sensitivity that are similar to the known effects of real-world status and power.

Previous research has demonstrated a link between how powerful an individual feels and the degree of motor excitation they exhibit when observing another individual acting. Hogeveen et al. (2014) used Transcranial Magnetic Stimulation (TMS) and electromyography (EMG) to examine whether such motor excitation associated with the observation of another person's action would be lower in high-power relative to low-power individuals. They found that individuals primed to feel powerful showed a reduction in the amplitude of motor-evoked potentials (MEPs) during action observation compared to those primed to feel powerless (Hogeveen et al., 2014). Motor excitation is inferred in TMS studies from the amplitude of MEPs, which is recorded from the muscle of interest via electromyography (EMG) during action observation. To elicit an MEP, a single, fixed intensity TMS pulse is applied over an area of the motor cortex that corresponds to a muscle underlying the observed action (Hogeveen et al., 2014). Variations in the amplitude of MEPs correspond to changes in the excitability of motor cortical output (Fadiga et al., 1995; Fadiga et al., 2005). Thus, given that the degree of motor excitation during action observation is tantamount to interpersonal sensitivity (Petroni et al., 2010), these results suggest that powerful individuals may be less socially attuned to others, relative to individuals with a lower sense of power (Hogeveen et al., 2014).

In concordance with the TMS study of Hogeveen et al. (2014), recently, work showed that individuals with low socio-economic status (SES) exhibited stronger electroencephalogram (EEG) Mu-suppression when viewing another individual's hand gestures, compared to their high SES counterparts (Varnum et al., 2016). Since Mu-suppression has been proposed as an indirect measure of mirroring activity (i.e., sensorimotor activity during action observation), this result was taken to suggest that mirroring is greater in those who are lower in SES (Varnum et al., 2016). Thus, together with the results of Hogeveen et al. (2014), this result supports the idea that higher levels of status and power are associated with lower levels of motor cortical output during action observation, compared to lower levels of power and status.

In this paper, we suggest that an individual's "follower to following" (f/f) ratio can be used as an index for online sense of status (and power). Specifically, individuals with an Instagram follower to following ratio of <1 (fewer users following them relative to the number of users that they follow) might be classified as Instagram "followers" and those with a ratio of >1 (more users following them relative to the number of users that they follow) may be classified as Instagram "leaders". Based on previous research examining status and power in the real world, we hypothesize that Instagram "followers" primed with their own f/f ratio will display increased motor cortical activity during action observation compared to Instagram "leaders". When taken together with the literature introduced earlier in this section, such a pattern would suggest that the follower/following (f/f) ratio indexes a form of Instagram status, and that this online status exerts effects on how these individuals process other people (i.e., their level of interpersonal sensitivity).

4.4 Methods

4.4.1 Participants

Thirty-eight volunteers (9 males, 29 females; *M* = 18.34 years, *SD* = 1.59) participated in this study for course credit. The sample size was determined based on numerous peer-reviewed between-group MEP studies, that achieved statistical power of 80% (*d* = 1.19; Fourkas et al., 2008; Fitzgibbon et al., 2012; Hogeveen et al., 2014). Participants were recruited from McMaster University's Psychology, Neuroscience and Behaviour Research Participation System. All participants were right-handed and had normal or corrected-to-normal vision. In addition, all participants were naïve with respect to the purpose of the experiment. Most importantly, all participants were screened for contra-indications to TMS prior to participation. The study was approved by the McMaster University Research Ethics Board (MREB) and participants provided informed consent before participation.

4.4.2 Materials and Methods

SuperLab (Version 4.2; Cedrus Corporation, San Pedro, CA, United States) was used to program this TMS experiment, and the stimuli were displayed on a 20-in. (50.8-cm) LCD monitor. The Magstim Rapid2 system was used to carry out the TMS. In addition, a Biopac psychophysiological recording system was used to record EMG data. MEPs were measured with surface electrodes placed over the abductor pollicis brevis (APB) muscle of participants' right hand. Similar to previous studies examining MEPs, the EMG signal was acquired with a 5,000-Hz sampling rate, amplified (to 5.0 mV), filtered (bandpass 10–500 Hz), and sent to a laptop computer for offline analysis (Hogeveen & Obhi, 2012). All inferential statistical analysis was performed with SPSS statistics.

The stimuli used in this experiment were clear videos depicting a right hand squeezing a rubber ball between the thumb and index finger (see Figure 4.1). The videos depicted the hand repeatedly squeezing the ball three to seven times.

The setup for TMS required the participant to first put on a swim cap, so that the experimenter could make markings for specific locations if necessary. The experimenter located the vertex and hand area of the left primary motor cortex (M1) using a standard landmark technique (Hogeveen & Obhi, 2012). After the M1 area was found and highlighted using a washable marker, the experimenter used a coil holder and arm to ensure that the coil positioning was stable throughout the TMS experiment (Lepage et al., 2010). Participants were also asked to sit completely back on a chair and remain as still as possible throughout the experiment. The experimenter sat behind the participant to ensure that the Magstim coil positioning and participant was as stable as possible throughout the TMS experiment. Similar to previous studies in the literature, stimulator output was lowered to determine the minimum intensity capable of eliciting visible MEPs (~1 mV peak to peak) on more than 50% of TMS pulses (Lepage et al., 2010; Enticott et al., 2012; Hogeveen &

Obhi, 2012; Loporto et al., 2013). Stimulation intensity ranged from 45% to 71% (M = 58%) of stimulator output. During the first block of the TMS experiment, baseline motor cortical output was established by delivering 30 TMS pulses while participants viewed a fixation cross (75 total trials). As such, there were 30 trials with TMS stimulation and 45 trials without TMS stimulation. After the baseline block, participants began the action observation block in which each trial comprised a fixation cross for 2,000 ms, followed by videos of the hand squeezing action from 3,750–8,750 ms (75 total trials). During action observation blocks, 30 trials included TMS stimulation and 45 trials did not include TMS stimulation. TMS pulses were delivered at points of maximum squeeze intensity on 30 of the trials and occurred 3,128, 4,328, 5,494, or 6,728 ms after trial onset in both blocks (Hogeveen & Obhi, 2012). As a result, the task and temporal information during baseline and action observation were identical. Therefore, the only difference between both blocks was whether the participant saw a fixation cross or action video.

4.4.3 Procedure

Participants completed the experiment in a testing room. They were seated in a chair in front of a computer monitor before the TMS setup began. Once the researcher ensured that the coil was in a stable position overlying the left motor cortex of the participants, they were given instructions about the task. Specifically, participants were told that they were about to watch two separate sets of videos. During the first block of videos, they were asked to just focus on the fixation crosses that would appear in the middle of the screen one at a time. While they were focusing on these crosses, they were also asked to count the number of seconds each fixation was presented. During the second video, participants were asked to focus on the ball squeezing action. While they were focusing on this action, participants were also asked to count the number of squeezes contained in each video.

4.4.4 Follower/Leader Priming

Importantly, before the participants were provided with any instructions about what they were about to watch on the computer monitor, they were asked to login to their Instagram account, write down how many followers they had and how many others they were following, and circle the larger number. In addition, they were also asked to indicate their perceived online status relative to their peers on Instagram by placing an ‘X’ on a 10 rung ladder, where those at the top had the most followers and those at the bottom had the least (adapted from Adler et al., 2000). These questionnaires effectively served to prime participants based on their f/f ratio and online status responses and also allowed us to classify them as Instagram leaders or followers. Before completing these questionnaires, participants were told that once they had completed their forms, they would need to place them into a file folder made available to them on their desk. The experimenter left the room while participants completed these forms and did not access this folder until after the experiment was complete. This procedure ensured that the experimenter was blind to the information provided by the participant and minimized any potential biases arising from the experimenter knowing the participant’s status as a “follower” or “leader”. After the TMS experiment, the information from these completed forms were used to categorize participants into an Instagram “leader” or “follower” group.

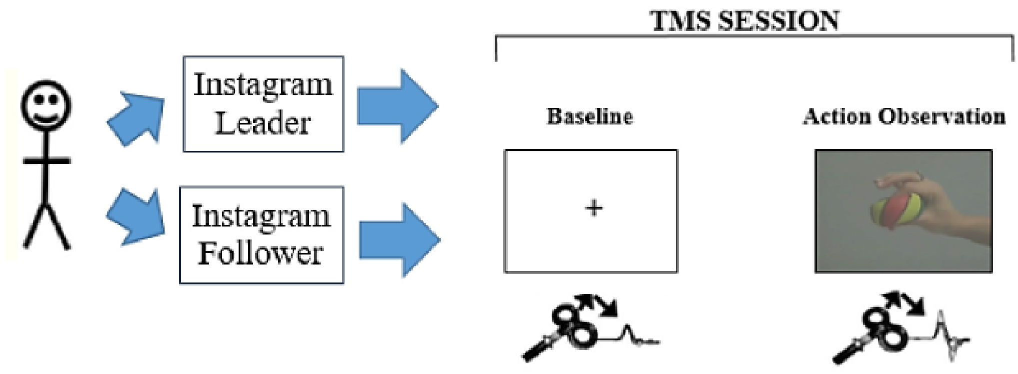


Figure 4.1 Schematic of the experiment. McMaster SONA, McMaster University Psychology Participant Pool; TMS, Transcranial Magnetic Stimulation.

4.5 Results

4.5.1 Data Analysis

The dependent measure in the experiment was MEP facilitation, which refers to the percent change in MEP amplitude between the baseline block and the action observation block for each participant. The MEP signal was quantified using the peak to peak method, using Biopac's Acknowledge software during offline analysis (Hogeveen et al., 2014). To examine differences associated with being a Leader or a Follower on Instagram, the sample was split into an Instagram Leader group and an Instagram Follower group. Participants were classified as Leaders if their followers/following ratio was > 1, and as Followers if their followers/following ratio was < 1. Finally, the data from all participants was used to examine the association between F/F ratio and Perceived Online Status, and the linear relationship between the F/F ratio and MEP Facilitation. Data was assessed for normality before conducting any statistical analysis.

4.5.2 Range of F/F Ratios

Our sample included participants who had a wide range of f/f ratios, ranging from 0.16 to 1.95 (M = 1.01, SD = 0.55). In addition, perceptions of online status ranged from 1 to 9 rungs on the perceived online status ladder (M = 4.40, SD = 2.43).

4.5.3 MEP Facilitation Analysis: Comparing Instagram Leaders and Followers

Prior to conducting inferential statistical analysis, trial data was examined for the presence of clear MEPs and trials were included or excluded accordingly. As a result, 10 participants had to be excluded from the analysis due to a lack of clear MEPs (fewer than 10) or excessive noise in the signal. For the included participants, we also removed specific trials per block based on the criteria of there being a clearly visible MEP. This resulted in the removal of 17.5% of trials in the baseline block and 13.9% of trials in the action observation block. Furthermore, for each participant, raw MEPs greater than 3 standard deviations from their mean were omitted from analysis (Hogeveen et al., 2014). This resulted in the removal of 1.03% data in the Baseline block and 0.57% in the Action Observation block. In regard to MEP Facilitation, participants with a mean change falling outside 2.5 standard deviations of the group average for each experimental condition (Leader, Follower) were excluded (Hogeveen et al., 2014). This procedure resulted in removal of one participant in the Follower group. After these pre-analysis procedures, the sample consisted of 13 participants in the Leader group and 14 participants in the Follower group.

The main question was examined by independent-samples t-test, with MEP Facilitation as the dependent variable and f/f ratio (i.e., leader or follower) as the independent variable.

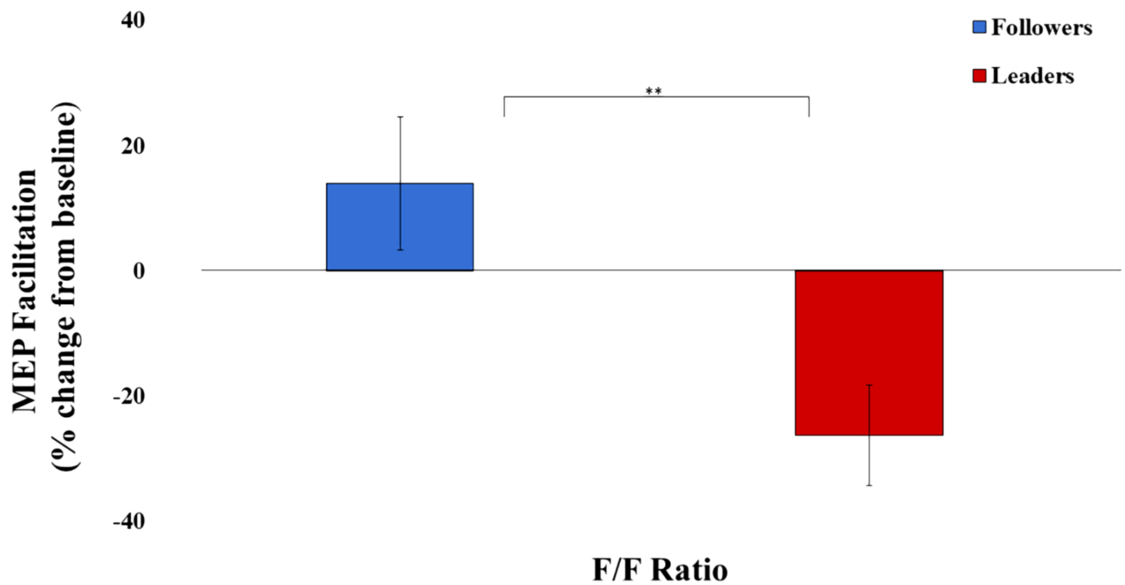


Figure 4.2 Motor-evoked potential (MEP) facilitation for both experimental conditions. *Significant at α = 0.05, **significant at α = 0.01, ***significant at α = 0.001. Error bars indicate SEM.

There was a significant difference between leaders and followers in MEP Facilitation, $t(25) = 2.98$, $p < 0.01$, $d = 1.15$. Specifically, Instagram followers (M = 13.9%, SD = 39.8%) displayed greater MEP facilitation compared to Instagram leaders, who appeared to show MEP suppression (M = - 26.2%, SD = 28.8%) (See Figure 4.2).

In order to verify MEP facilitation and check whether MEPs changed over the course of a block, we divided the MEPs recorded during both baseline and experimental conditions into two temporal bins (the first half of TMS trials within a block and the second half of TMS trials within a block), so that the data could be normalized within each temporal bin. For each bin, we performed a *t*-test comparing normalized MEPs against zero. The independent *t*-test against zero was significant for the follower group for both Bin 1 ($M = 0.40$, $SD = 0.48$, $t(13) = 3.15$, $p < 0.01$) and Bin 2 ($M = 0.69$, $SD = 0.63$, $t(13) = 4.10$, $p <$

0.01). Thus, there was MEP facilitation during action observation for this particular group. However, we did not find a significant difference against zero for leaders for either Bin 1 (*M* = 0.05, *SD* = 0.73, *t*(12) = 0.261, *p* = 0.798) or Bin 2(*M* = - 0.07, *SD* = 0.28, *t*(12) = - 0.872, *p* = 0.400). Overall, there was motor facilitation for followers, but not for leaders. Finally, the fact that *t*-tests against zero were not different for bins 1 and 2 suggests similar MEP responses during early and late trials (i.e., that MEPs did not change appreciably over the course of a block).

4.5.4 Correlation between F/F ratio and Perceived Online Status

The key question of whether an association existed between the f/f ratio and perceived online status was confirmed by a positive correlation $r = .718$, $n = 27$, $p < 0.001$).

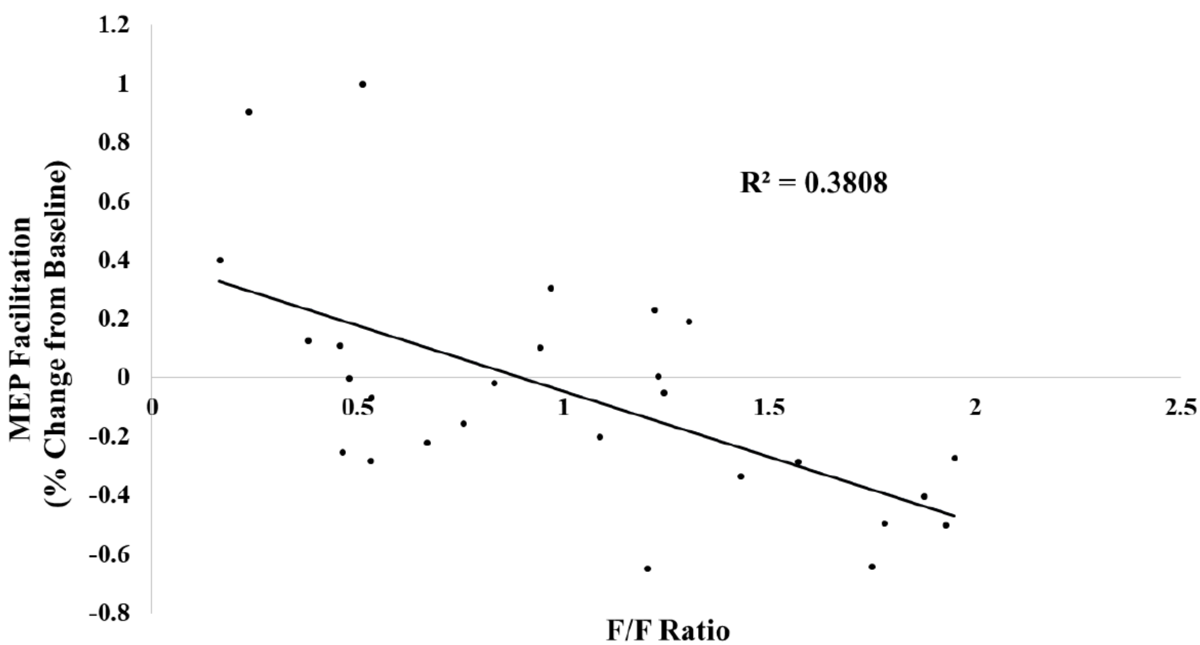


Figure 4.3 The following/follower ratio was linearly related with MEP facilitation.

4.5.5 Linear Regression between MEP Facilitation and F/F ratio

For completeness, we treated the f/f ratio as a continuous variable and conducted a linear regression analysis to determine whether differences in the f/f ratio predicted differences in MEP facilitation. This regression was significant [$\beta = -0.617$, $t(25) = -3.92$, $p < 0.01$, $R^2 = 0.381$]. (See Figure 4.3).

4.6 Discussion

The current study investigated whether priming individuals by asking them to provide their Instagram f/f ratio and to rate their own perceptions of online status, are related to MEP facilitation during action observation. Consistent with previous findings, our results showed that motor cortical activity was higher for observed actions in individuals primed with a low sense of online status compared to their high online status counterparts. More importantly, this study has extended previous research examining the influence of status and power on motor cortical output, by looking at an online index of social status, linked to user followers/following numbers on Instagram. We found that the Instagram follower group (individuals who had fewer followers than they were following; f/f ratio < 1) exhibited an increase in MEP facilitation during action observation compared to the leader group, who appeared to show MEP suppression (f/f ratio > 1). Regression analyses also showed that there was a strong negative relationship between the f/f ratio and MEP facilitation. In addition, there was a significant positive association between f/f ratio and perceived online status.

The amplitude of MEPs are an index of motor cortical output, which reflects the influence of the observed action on the motor system of the observer. The results of this study support previous findings from cognitive neuroscience studies showing that increases in both power and socioeconomic status are associated with decreasing levels of mirroring (Hogeveen et al., 2014; Varnum et al., 2016). The current study is the first (to our knowledge) to show that the sense of *online status* affects MEP facilitation. In other words, the sense of online status affects motor cortical activity such that those low in online status exhibit higher levels of activity compared to those high in online status.

The results of this study are consistent with previous claims that individuals of high status and power often fail to individuate others (Fiske, 1993; Russell & Fiske, 2010). That is, previous claims suggest that feeling powerful leads to less sensitivity to individuating information (and a correspondingly greater reliance on stereotypes) (Galinsky et al., 2003). In the present study, we find that feeling high in status reduces mirroring of observed actions – an effect that we suggest is tantamount to "reduced interpersonal sensitivity" (Buccino et al., 2004; Avenanti et al., 2010; Gutsell & Inzlicht, 2010). Although motor activation during action observation has been purported to relate to the capacity to process and comprehend the behaviour of others, as well as important social capabilities such as empathizing and inferring mental states, direct evidence supporting some of these ideas is scarce (Agnew et al., 2007; Pfeifer et al., 2008; Lamm & Majdanzic, 2015). Despite this, the tendency for the brain to simulate (or "mirror") the actions and experiences of others undoubtedly relates to sensitivity to the actions of others and has been reliably confirmed (e.g., Preston & de Waal, 2002; Rizzolatti & Craighero, 2004; Jackson et al., 2006; Lamm & Singer, 2010; Waytz & Mitchell, 2011; Bernhardt & Singer, 2012).

The current results are also in line with recent studies that have focused on examining the relationship between real life status and power and sensorimotor activity as indexed via measures such as EEG Mu-suppression and motor activity as indexed by MEPs elicited via TMS. Specifically, Varnum et al. (2016) have shown that lower socioeconomic status is associated with stronger Mu-suppression when viewing another's hand gestures, suggesting that the putative human mirror system (HMS) may be more responsive among those who are lower in status. Similarly, Hogeveen et al. (2014) used TMS to elicit MEPs in individuals who were primed to a high power condition, a low power condition, or a neutral condition. Their results revealed a reduction in MEP facilitation in high power participants relative to low power participants (Hogeveen et al., 2014). Our study extends these results to perceptions of online status, and corroborates that high status seems to reduce the tendency to automatically mirror others. Given that differences in motor resonance have been linked to differences in status and power (Hogeveen & Obhi, 2013; Hogeveen et al., 2014; Varnum et al., 2016), it is surprising that very few studies have begun to address the question of whether a person's online sense of status and offline sense of status are concordant or dissimilar in terms of their effect on motor cortical output. An important question for future work is when and whether online status and offline status exert similar effects (within participants) on a host of social cognitive processes beyond MEP facilitation during action observation.

Our results indicate that online sense of status and power is associated with differences in motor cortical output during action observation. These findings not only support previous studies examining the effect of real-life status and power on motor resonance, they also extend these findings to an online context. However, there are a number of potential limitations to our study. First, there was a gender imbalance between Instagram groups, there were more female participants in the Instagram Leader group (n = 12) compared to the Instagram Follower group (n = 9). Although this is not ideal, to our knowledge, gender differences in MEP facilitation during action observation have not been reported in the literature (Hari, 2006; Lepage et al., 2008). Second, the lack of a control muscle makes it problematic to extend this discussion to differences in *motor resonance* specifically between Instagram leaders and followers. This is because a strict definition of motor resonance requires the demonstration of muscle specificity, and because we did not record from a control muscle, we must limit our discussion to effects of status on motor cortical output during action observation. As such, future studies are encouraged to address this issue by including a control muscle unrelated to the action in question. Third, participants in this study engaged in only one baseline block before the action observation block, similar to previous studies examining group differences in MEP facilitation during action observation (Obhi et al., 2011; Hogeveen et al., 2014). A better approach would be to incorporate pre and post baseline blocks to take into account potential drifts/changes in motor cortical excitability across the experiment. This approach would allow a more definitive interpretation of any findings. As such, future studies are encouraged to adopt a pre and post baseline approach. Fourth, although we attempted to examine differences in *online status*, we did not collect information from participants about their actual *real-life status*. This leaves open the possibility that our results were driven by differences in real-life status rather than online status or that real-life status and online status are the same thing. While we acknowledge this possibility, we propose that understanding the relationship between real-life status and online status is critical for future work in that it relates to the potential attributes of different versions of the self (and there are cases in which these selves may be discordant). Despite this limitation, our data are consistent with our hypotheses and with previous studies from multiple labs. In addition, although the findings of this paper along with those from other recent papers (Hogeveen et al., 2014; Varnum et al., 2016) suggest that the link between power, status and mirroring is robust, we are unable to say anything about the precise functional role that "neural mirroring" might play in complex processes such as empathy and capacities such as decoding the actions of others. Even without this knowledge though, we suggest that automatic mirroring of others, can itself be used as a useful marker of sensitivity to the behaviour of others (i.e., as a measure of "interpersonal sensitivity").

In summary, we found that lower Instagram status is associated with higher levels of motor cortical output as indexed by MEP facilitation during action observation. These findings suggest that online and real-life status and power might exert concordant effects on motor cortical output. This pattern of data could account for the everyday experience that people in positions of power and those with high status sometimes seem less attuned to others compared to people who feel relatively low in status and power. Our work also opens up a new question about the effects of online status versus real life status on a host of other social cognitive processes. In this regard, future work should consider probing the conditions in which online and "real-world" status exert similar or different effects on social cognitive processing.

Chapter 5

The effects of online status on self-other processing as revealed by automatic imitation

Farwaha, S., & Obhi, S. (2021). The Effects of Online Status on Self-Other Processing as Revealed by Automatic Imitation. *Social Cognition, 39*, 295–314.

5.1 Preface

In the previous chapter, we explored how online status may modulate motor cortical output during action observation using a physiological method. In this chapter, we will aim to extend and corroborate the findings from Chapter 4 by exploring how online status modulates automatic imitation across two experiments. In Chapters 2 and 3, we explored how social factors such as status and power modulate performance on the automatic imitation task using a community-based sample, however, in this chapter we will rely solely on an undergraduate sample of Instagram users since they are the most active on the platform. In both experiments, we found that Instagram leaders exhibited a significantly lower interference effect during the automatic imitation task compared to Instagram followers. Overall, these findings suggest that online status and real-world (offline) status may have concordant effects on automatic imitation. The implications of these findings are discussed further in the chapter.

5.2 Abstract

High status individuals have been found to be less attuned to the behaviour of others in the social environment. An important question is whether social status in an online setting affects social information processing in a way that resembles the known effects of real-world status on such processing. We examined differences in automatic imitation between Instagram "leaders" and "followers". In Experiment 1, we found that followers exhibited more automatic imitation than leaders. Experiment 2 sought to establish whether this effect depended on status being salient, or whether it would occur spontaneously in the absence of priming. Results confirmed that thinking about status prior to the task is necessary for producing the pattern of effects in which high status individuals exhibit less automatic imitation than lower status individuals. We discuss our findings in relation to the effects of online status on self-other processing as assessed in the automatic imitation task.

5.3 Introduction

Humans have a fundamental need to belong to various social groups, where a rich array of social behaviours take place (Mathes, 1978; Baumeister & Leary, 1995). For most of human history, social interactions have occurred between people who are present in the same physical space, at the same time – a face-to-face conversation is a perfect example. Within social groups, a core feature of human (and other primate) social interactions is the presence of status hierarchies, and the associated thoughts and behaviours of those who are relatively high in status versus those who are relatively low in status (Graf et al., 2012; Maner & Menzel, 2013; Keltner & Cordaro, 2017). There is now a voluminous literature in social psychology on the effects of status and the related construct of social power on social cognition (Fiske, 1993; Keltner et al., 2003; Smith & Trope, 2006; van Kleef et al., 2008). Since powerful individuals control the valued social, economic, and physical outcomes of others (Keltner et al., 2003), they can devote more of their attention to the pursuit of their goals, and they tend not to devote much attention toward less powerful others. In contrast, powerless individuals tend to direct their attention toward powerful others because they exert control over their valued outcomes (Fiske, 1993; Foerster et al., 2005; Fiske & Berdahl, 2007). Thus, in real life social groups, there exists a dependence asymmetry between those at the top of the social hierarchy and those lower down, which is also associated with a host of effects on social information processing.

Despite a relatively rich literature on status and power in face-to-face interactions, little is known about how online social status affects social information processing. The Internet provides myriad opportunities for previously impossible forms of social interaction, the properties and implications of which are yet to be fully appreciated. These newer forms of social interaction are quite distinct from traditional human interaction in that they allow individuals who are spatially separated to consume and respond to information generated by others in (near) real-time. This type of online social interaction can take place in the form of instant messaging on platforms such as Facebook or via commenting on a newly posted photograph on sharing platforms such as Instagram, for example. Given the huge popularity of these forms of social interaction across various social media platforms, fundamental questions arise about the similarities and differences between online and real-world social interactions.

In the current study, we focus on the nature of social interactions on Instagram, in which statistics such as the number of people following an individual versus the number of people that that individual follows, index a form of Instagram status hierarchy. “Following” an individual on Instagram involves subscribing to their profile and all of the content they post. In general, status is based on the respect and esteem that an individual is afforded by others, and individuals generally have a personal sense of where they stand relative to others in the social hierarchy (Adler et al., 2000)[1]. Within the Instagram context, individuals who have more followers than they are following exhibit a greater perceived status compared to those who have profiles with the opposite pattern (DeSouza & Ferris, 2015; McCain & Campbell, 2016; Sherman et al., 2016). We suggest that an individual’s “follower to following” (f/f) ratio can be used to index online status. Specifically, individuals with an Instagram follower to following ratio of <1 might be classified as Instagram “followers” and those with a ratio of >1 may be classified as Instagram “leaders”. The current study is inspired by the previously demonstrated effects of status on imitative motor processing. To preview our main question, we ask whether social status hierarchy on Instagram is associated with effects on imitative motor processing that are similar to the known effects of real-world status on imitative motor processing (e.g., Hogeveen et al, 2014). We assess these effects through performance on an automatic imitation task.

Human societies and cultures depend on the sharing of ideas and cultural practices across individuals. A key capacity for the transmission of social and cultural information and

[1]Status relates to power in that it often allows one to control the social outcomes of value to others. Unsurprisingly, people want to feel accepted by those who are relatively high in status. However, although status and power are often considered together, they are separate constructs and can exert dissociable effects in certain cases.

practices is imitation. Imitation occurs when an individual performs an action that is topographically similar to what they observe another doing (Stürmer et al., 2000). Such is the utility of the imitative tendency in humans—that there are well-established paradigms for assessing so-called automatic imitation. Many researchers argue that automatic imitation is the result of a human mirror mechanism (Blakemore & Frith, 2005; van Schie et al., 2008; Ferrari et al., 2009). Specifically, automatic imitation is thought to depend on a "motor resonance" mechanism that directly maps an observed action onto an internal motor representation of the same action (Fadiga et al., 1995; Iacoboni et al., 1999; Aglioti et al., 2008). This motor resonance process has also been proposed to play a role in an individual's processing and comprehension of the behaviour of others, and many have suggested links with social proficiencies such as empathy and theory of mind (Agnew et al., 2007; Pfeifer et al., 2008). As such, this process of inner simulation of observed actions and associated thoughts and feelings may form the foundation for more complex social cognition.

Recent work using electroencephalography (EEG) has shown that high status individuals are less socially attuned to others compared to their low status counters, as indexed by differences in Mu-suppression during action observation (Varnum et al., 2016). As such, it appears that higher levels of status are associated with lower levels of motor resonance compared to lower levels of status. Interestingly, similar findings have also been reported in the literature examining the link between motor resonance and social power (a social construct that relates to, but is distinct from, status). Specifically, Hogeveen and colleagues (2014) used transcranial magnetic stimulation (TMS) to examine whether there were differences in motor resonance between high power and lower power individuals when they observed another perform an action. This prediction was based on previous evidence suggesting that high power individuals pay less attention to others, and that empathy can be impaired by power (e.g., Fiske & Berdahl, 2007; Van Kleef et al, 2008). Hogeveen and colleagues (2014) found that individuals in the high power prime condition showed a reduction in the amplitude of motor-evoked potentials (MEPs) during action observation, whereas their low power prime counterparts showed relatively larger MEPs (Hogeveen et al., 2014). Thus, these authors concluded that high power individuals in their study showed reduced processing of others (possibly due to reduced attention), relative to low power individuals.

It is important to note that, although social power and status are distinct constructs, they are also related in that they both pertain to hierarchy (Magee & Galinsky, 2008). However, whereas social status is rooted in the admiration and respect that an individual garners from others, social power is more about the ability to control, withhold, and allocate valued resources. That said, to the extent that social outcomes are valued resources, high status individuals can control access to them via their acceptance or rejection of others as part of their social group. Thus, there can be cases in which there is considerable overlap between high status and power as well as cases in which a person has high power but is not admired or respected. Here, we are concerned primarily with individuals' social status as indexed by their Instagram statistics, but we acknowledge that our results may touch upon the related construct of power.

Relatedly, a reliable indirect behavioural measure of motor resonance is the automatic imitation task (AIT) (Brass et al., 2001). In this task, participants perform finger lift actions (index or middle finger) to on-screen numerical cues (Brass et al., 2001; Obhi et al, 2014). A video of an on-screen hand performing either an index or middle finger movement is also presented on-screen at the same time as the cue (Heyes, 2011). Individuals typically perform worse on incongruent trials, where the on-screen hand performs the opposite movement to what is required of the participants based on their cue, compared to congruent trials (Brass et al., 2001; Butler et al., 2015). The reaction time difference between both of these trial types is referred to as the interference effect, argued to be due to the automatic activation of the same action as the one observed on-screen (although there are also spatial compatibility effects) (Catmur & Heyes, 2011). The interference effect in the AIT is sensitive to the influence of a range of social moderator variables such as levels of sub-clinical narcissism, pro-social mindset, and self-focus (e.g., Spengler et al., 2010; Cook & Bird, 2011; Obhi et al, 2014). However, it is important to note that there remains some debate on the susceptibility of automatic imitation to modulation by social factors, especially personality traits, and even whether automatic imitation underlies real life social phenomena (see Genschow et al., 2017; Ramsey, 2018; Cracco & Brass, 2019). Indeed, Genschow and colleagues (2017) did not find a correlation between personality traits and automatic imitation or between automatic imitation and more naturalistic mimicry (see also Ramsey, 2018). In light of these mixed results, the findings of this study will contribute meaningfully to the existing literature.

In the current study, we hypothesize that Instagram leaders may be less susceptible to "other" activated motor representations (activated via action observation) than Instagram followers, and will thus display less interference on the AIT, compared to Instagram followers. In line with previous research, we also predicted that the f/f ratio will correlate with subjective reports of online status.

5.4 Experiment 1

5.4.1 Methods

Participants

Forty-three volunteers (6 males, 37 females; *M* = 20.09 years of age, *SD* = 1.82) participated in this study for course credit. Participants were recruited from McMaster University's Psychology, Neuroscience and Behaviour Research Participation System. All participants were right-handed and had normal or corrected-to-normal vision. Most importantly, all participants were naïve with respect to the purpose of the experiment. The study was approved by the McMaster University Research Ethics Board (MREB), and participants provided informed consent before participation. The sample size was determined prior to data collection and was based on previous peer-reviewed studies examining how social modulators affect self-other processing using the AIT (Obhi et al, 2014; Genschow et al., 2019).

Stimuli

The automatic imitation task (AIT), as originally developed by Brass and colleagues

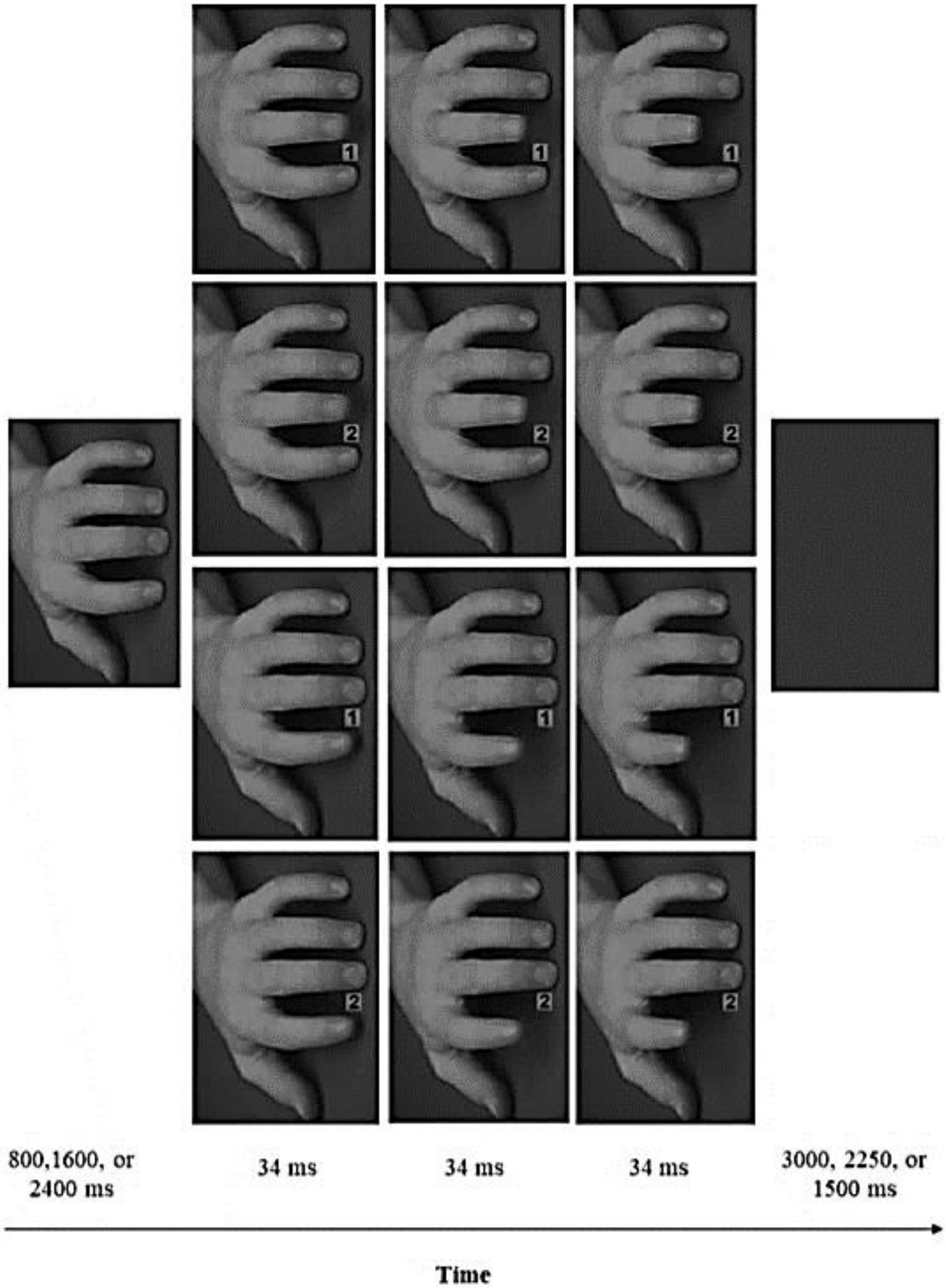


Figure 5.1 The five frames of the incongruent index finger, congruent middle finger, congruent index finger, and incongruent middle finger.

(2001), was programmed using Superlab v.4 (Cedrus, San Pedro, CA) and displayed on a 19-inch computer monitor. Each experimental trial depicted either an index or middle finger lift movement using a sequence of images (see Figure 5.1). In order to reduce any potential spatial compatibility effects (Bach & Tipper, 2007; Gillmeister et al., 2008), the stimulus was rotated and presented vertically (see Figure 5.1), while the participant rested their own hand horizontally on the computer keyboard.

The experiment contained 240 trials in total, split into 4 randomized blocks of 60 trials each. Each block contained 15 repetitions of each trial type, and there were 4 types of trials comprising: 60 congruent index finger trials, 60 congruent middle finger trials, 60 incongruent index finger trials, and 60 incongruent middle finger trials. Participants were asked to perform speeded lifts with their index finger if a numeric cue of "1" appeared on between the index and middle finger stimuli and do the same with their middle finger if a numeric cue of "2" appeared.

Procedure

Participants completed the AIT in a testing room while the experimenter sat behind them. Before beginning the AIT, participants were instructed to hold down both the "v" and "b" key with their index and middle finger respectively and performed speeded lifts to the numerical cues on the screen. A written version of these instructions was also provided on-screen. In addition, 8 practice trials were provided before participants began with the actual experiment.

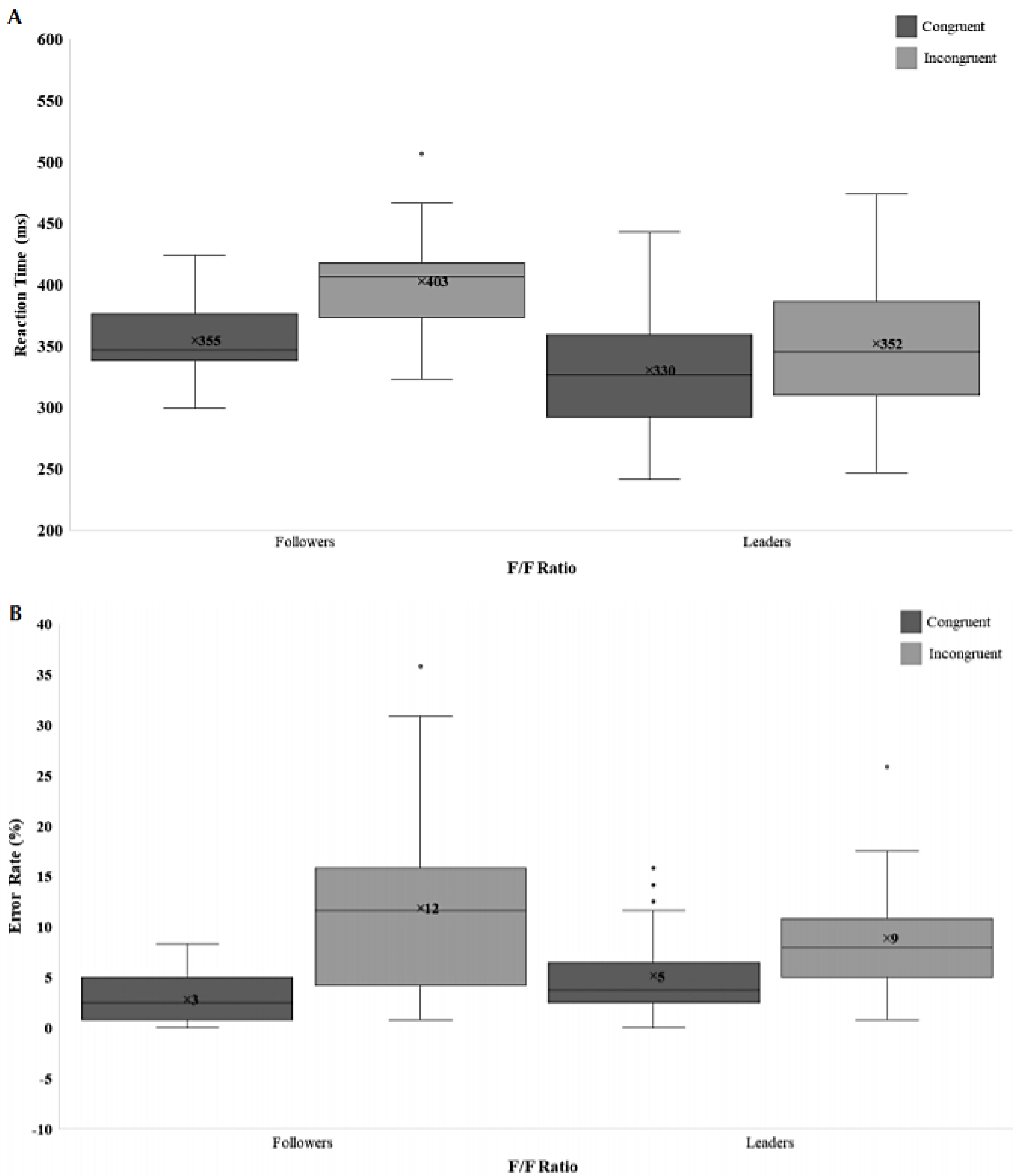


Figure 5.2 (A) Reaction time during congruent vs. incongruent trials. (B) Error rate during congruent vs. incongruent trials.

Follower/Leader Priming

Importantly, before the participants began the practice trials for the AIT, they were asked to login to their Instagram account, write down how many followers they had, how many others they were following, and circle the larger number. In addition, they were also asked to indicate their perceived online status relative to their peers on Instagram by placing an "X" on a 10-rung ladder, where those at the top had the most followers and those at the bottom had the least (adapted from Adler et al., 2000). From this information, participants were later categorized into an Instagram 'leader' or 'follower' group. Before completing these questionnaires, participants were told that once they had completed their forms, they would need to place them into a file folder made available to them on their desk. The experimenter left the room while participants completed these forms and did not access this folder until after the study was complete. This procedure ensured that the experimenter was blind to the information provided by the participant and minimized any potential biases arising from the experimenter knowing the participants status as a follower or leader.

5.4.2 Results

Data Analysis

Dependent measures in the experiment were reaction time (RT) and error rate (ER), which were used to calculate a RT (or ER) interference effect (the difference between incongruent and congruent trials). To examine differences associated with being a leader or a follower on Instagram, the sample was split into an Instagram Leader group and an Instagram

Follower group. Participants were classified as leaders if their followers/following ratio was > 1, and as followers if their followers/following ratio was < 1.

Range of F/F Ratios

Our sample included a wide range of f/f ratios, ranging from 0.31 to 4.11 (M = 1.23, SD = .85). In addition, perceptions of online status ranged from 1 to 10 rungs on the perceived online status ladder (M = 5.53, SD = 3.01).

Reaction Time (RT) Analysis: Comparing Instagram Leaders and Followers

Prior to conducting inferential statistical analysis, error trials in which the participant lifted the incorrect finger were removed. Response times that were more than 3 standard deviations away from the mean for each condition (1.52% of congruent trials, 1.75% of incongruent trials) as well as trials without a recorded response, were removed. As such, data from 21 followers and 22 leaders were subjected to analysis.

For the RT analysis, a 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent RT, incongruent RT) and one between-subjects factor (f/f ratio group: leader, follower), was conducted. This test revealed a significant main effect of congruence $F(1, 41) = 74.0$, $p < 0.001$, $\eta^2 p = .643$, as well as a significant congruence by follower/following ratio interaction, $F(1, 41) = 10.2$, $p = 0.003$, $\eta^2 p = .200$. Participants in both the leader and follower groups executed significantly faster responses on congruent trials (leader: M = 330ms, SD = 49ms; follower: M = 355ms, SD = 34ms) than on incongruent (leader: M = 352ms, SD = 58ms; follower: M = 403ms, SD = 46ms) trials

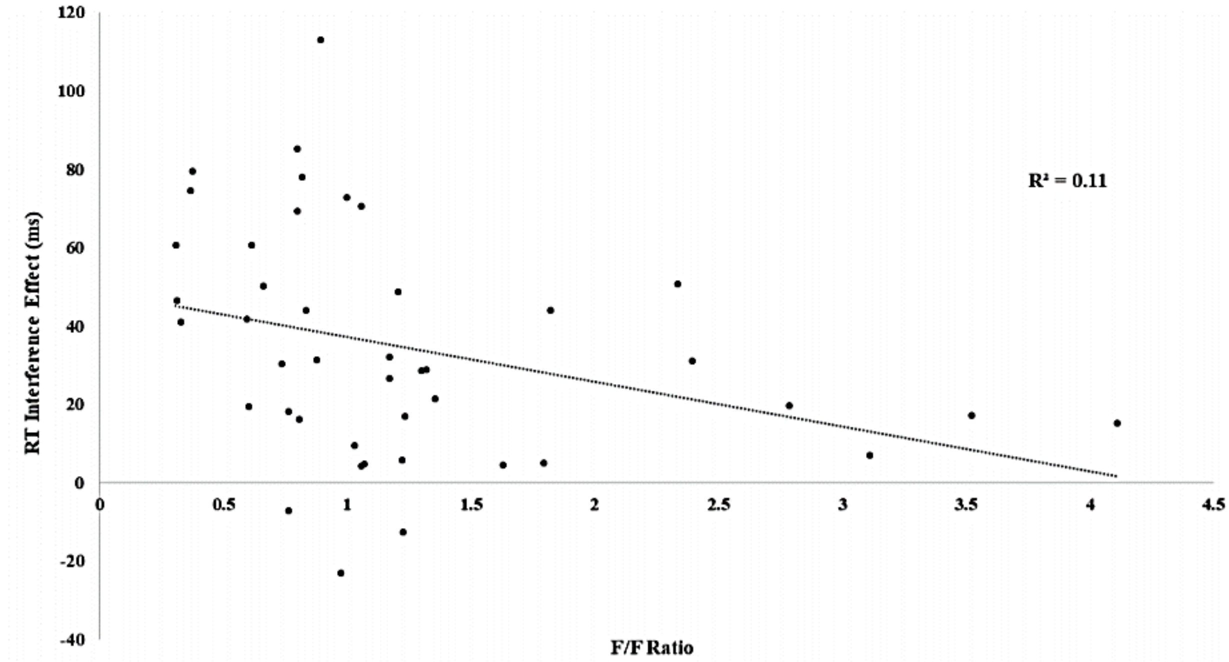


Figure 5.3 There was a linear relationship between the follower/following ratio and automatic imitation, with higher f/f ratios significantly predicting the degree of RT interference (i.e., incongruent RT – congruent RT).

[leader: $t(21) = –5.32$, $p < 0.001$, $d = -1.13$; follower: $t(20) = –6.74$, $p < 0.001$, $d = -1.47$] (see Figure 5.2A). The size of the RT interference effect (incongruent RT – congruent RT) was significantly higher for the follower group ($M = 48$ms, $SD = 33$ms) relative to the leader group ($M = 22$ms, $SD = 19$ms; $t(41) = 3.20$, $p = .003$, $d = 0.976$.

Error Rate (ER) Analysis: Comparing Instagram Leaders and Followers

For the ER analysis, a 2 x 2 mixed model ANOVA, with one within-subjects factor (congruence: congruent ER, incongruent ER) and one between-subjects factor (f/f ratio group: leader, follower), was conducted. The ANOVA showed a significant main effect of congruence, $F(1, 41) = 41.79$, $p < 0.001$, $\eta^2p = .505$, as well as a significant congruence by f/f ratio interaction, $F(1, 41) = 7.10$, $p = 0.011$, $\eta^2 p = .148$. Participants in both groups made fewer errors in congruent trials (leader: $M = 5\%$, $SD = 5\%$; follower: $M = 3\%$, $SD = 2\%$) compared to incongruent trials (leader: $M = 9\%$, $SD = 6\%$; follower: $M = 12\%$, $SD = 9\%$) [leader: $t(21) = –4.51$, $p < 0.001$, $d = -0.962$; follower: $t(20) = –4.94$, $p < 0.001$, $d = -1.078$] (see Figure 5.2B). The ER interference effect was larger in the follower group ($M = 9\%$, $SD = 8\%$) compared to the leader group ($M = 4\%$, $SD = 4\%$; $t(41) = 2.66$, $p = .011$, $d = .813$).

Correlations between f/f ratio and perceived online status

A key question was whether there was an association between objective online status (as indexed by the f/f ratio) and the subjective sense of online status. Correlation analysis showed that there was a positive correlation between perceived online status and f/f ratio group, $r = .699$, $n = 43$, $p < .001$.

Does leader/follower status predict automatic imitation?

Relationship between f/f ratio and RT interference

A regression analysis (i.e. treating the f/f ratio as a continuous variable) revealed that the f/f ratio significantly predicted RT interference in the AIT, β = -11.4, $t(41) = -2.25$, $p = .030$, $R^2 = .110$ (See Figure 5.3).

Relationship between f/f ratio and ER interference

A regression analysis (i.e. treating the f/f ratio as a continuous variable) showed that differences in the f/f ratio did not significantly predict differences in ER interference (although the relationship between f/f ratio and ER showed a trend that was consistent with the relationship between f/f ratio and RT interference), β = -2.22, $t(41) = -1.81$, $p = .077$, $R^2 = .074$].

5.4.3 Experiment 1 Discussion

Experiment 1 investigated whether the Instagram follower/following ratio is related to performance in the AIT. We also assessed subjective perceptions of online (i.e., Instagram) status and determined whether these perceptions were associated with objective follower/following ratios. Participants demonstrated a significant degree of automatic imitation, as indexed by interference effects for RT and ER measures (Heyes, 2011). In particular, participants were faster and made fewer mistakes during congruent trials (i.e., when the numeric cue prompted the same movement to that depicted by the on-screen hand) compared to incongruent trials (i.e., when the numeric cue prompted a different movement to that depicted by the on-screen hand). More importantly, the leader group (individuals who had more followers than they were following; f/f ratio > 1) exhibited significantly less interference than the follower group (f/f ratio < 1). In other words, leaders automatically imitated the action stimulus significantly less compared to followers. Regression analyses demonstrated a significant negative relationship between f/f ratio and RT interference. Interference in the AIT is thought to reflect the influence of the observed action on the motor system of the observer (Fadiga et al, 1995; Heyes, 2011; Obhi, 2016). Thus, these findings suggest that differences in online status are linked to differences in the tendency to mirror the actions of another individual. Since automatic imitation is thought to index self-other control processes, these results suggest that this control process is affected when individuals think about their online status, such that individuals high in online status are less impacted by the actions of others, when performing a self-related action. This pattern of data showing reduced interference in leaders compared to followers is also consistent with prior research showing that high power individuals mirror the actions of others less than low power individuals (Hogeveen et al, 2014; see also Varnum et al, 2016).

We also observed a positive association between objective follower to following ratios and the subjective sense of online status, which bolsters the notion that f/f ratio is a useful index of Instagram status.

In Experiment 1, participants were asked to login to their Instagram account and record their information *before* completing the AIT. However, priming individuals with their Instagram status before completing the AIT, without running a baseline AIT block, makes it difficult to determine whether the differences in automatic imitation between followers and leaders depended on the Instagram manipulation or whether they would have occurred spontaneously. To address this question, we conducted a second experiment comprising both a baseline and post-prime AIT block, and a much larger sample size. We hypothesized that high and low status individuals would show the same pattern of automatic imitation as in Experiment 1 after f/f ratio priming. We remained open as to the pattern of automatic imitation in the baseline block.

5.5 Experiment 2

5.5.1 Methods

In the second experiment, participants completed the AIT once before the Instagram manipulation (pre-prime), and once immediately after (post-prime). At the very end of the experiment, participants were also asked to complete the Big Five Personality Inventory (BFI). These responses were used to address a separate experimental question and are therefore not reported in the current study.

Participants

An a priori power analysis was used to determine the sample size based on a medium effect size and in order to reach adequate power of 0.80. Thus, 128 volunteers (24 males, 104 females; *M* = 18.77 years of age, *SD* = 1.31) participated in this study for course credit. Participants were recruited from McMaster University's Psychology, Neuroscience and Behaviour Research Participation System. All participants were right-handed and had normal or corrected-to-normal vision. Importantly, all participants were naïve with respect to the purpose of the experiment. The study was approved by the McMaster University Research Ethics Board (MREB) and participants provided informed consent before participation.

Procedure

The protocol for informing participants on how to complete the automatic imitation task remained the same as in Experiment 1. Participants were informed at the beginning of the study that they would need to perform speeded finger lifts to the "1" or "2" numerical cue that would appear on the screen. However, in this study, participants were asked to complete this task twice. These two AIT sessions were separated by the Instagram questionnaire used to prime individuals to either a "follower" or "leader" condition using their own Instagram information. As such, the first AIT session served as the baseline condition, and the second session served as the post-prime condition.

Follower/Leader Priming

During the priming session, participants provided the same Instagram information required in Experiment 1. The protocol for administering this questionnaire also remained the same, ensuring that the experimenter was blind to participants' Instagram information in order to minimize any potential biases in the experiment. After the priming session, participants were immediately asked to complete a second session of the AIT.

5.5.2 Results

Data Analysis

The dependent measure of interest was the reaction time (RT, ms) and error rate (ER, %) across the experimental conditions. Importantly, the RT and ER difference between incongruent and congruent conditions – the so-called interference effect – was the main derived measure (i.e., derived from the RT and ER measures in respective conditions). To examine the effects of being a leader or a follower on Instagram, the sample was split into an Instagram leader group (f/f ratio > 1) and an Instagram follower group (f/f ratio < 1).

Range of F/F Ratios

Participants reported a wide range of f/f ratios, ranging from 0.10 to 3.77 (M = 1.11, SD = .51). In addition, perceptions of online status ranged from 1 to 8 rungs on the perceived online status ladder (M = 4.40, SD = 1.77).

Reaction Time (RT) Analysis: Comparing Instagram Leaders and Followers

Prior to conducting inferential statistical analysis, error trials in which the participant lifted the incorrect finger were removed. In addition, response times that were more than 3 standard deviations above or below the mean for each condition (1.50% of congruent trials, 1.71% of incongruent trials) as well as trials without a recorded response were removed. Finally, 6 participants were excluded from the analyses due to missing follower or following information on their Instagram questionnaires. As such, data from a total of 57 followers and 65 leaders was subjected to analysis.

	F/F Ratio	Baseline Congruent	Baseline Incongruent	Post-Prime Congruent	Post-Prime Incongruent
Mean	Followers	370	403	353	392
	Leaders	370	420	361	390
Std. Error Mean	Followers	5.74	6.31	4.79	5.79
	Leaders	4.14	6.16	4.48	5.75
Standard Deviation	Followers	43.4	47.7	36.2	43.7
	Leaders	33.4	49.7	36.1	463

Table 5.4 Means, Standard Error of the Means, and Standard Deviations for Reaction Time (ms) of Followers and Leaders Across Trial Type and Block.

Mean RT data for congruent and incongruent conditions for leaders and followers across blocks is presented in Table 5.4. For the RT analysis, we conducted a 2 x 2 x 2 mixed model ANOVA, with two within-subject factors: (Congruency: Congruent, Incongruent) & (Block: Baseline, Post-Prime) and one between-subjects factor (F/F Ratio: Follower, Leader). The analysis revealed a significant main effect of congruency, $F(1, 120) = 434.05$, $p < 0.001$, $\eta^2p = 0.783$ and a significant main effect of block, $F(1, 120) = 64.49$, $p < 0.001$, $\eta^2p = 0.350$. There was a significant two-way interaction between congruency x block $F(1, 120) = 44.98$, $p < 0.001$, $\eta^2p = 0.273$, showing that automatic imitation differed between baseline and post-prime conditions. Finally, there was a significant three-way interaction between congruency x block x f/f ratio, illustrating that the congruence x block effects differed for leaders and followers $F(1, 120) = 120.29$, $p < 0.001$, $\eta^2p = 0.501$ (Figure 5.5a). In particular, the congruency x block interaction was stronger for leaders $F(1, 64) = 184.6$, $p < 0.001$, $\eta^2p = 0.743$ than for followers $F(1, 56)= 7.69$, $p = .008$, $\eta^2p = 0.121$. Finally, for completeness, we directly compared the RT interference effect for leaders and followers in both the baseline and post-prime blocks. This analysis confirmed that followers exhibited less RT interference than leaders in the baseline block (leaders (baseline) = 50ms, SD = 25ms; followers (baseline) = 33ms, SD = 18ms; $t(120)= -4.19$, $p < 0.001$, $d = -0.761$), but more RT interference than leaders in the post-prime block (leaders (post-prime) = 29ms, SD = 21ms; followers (post-prime) = 39ms, SD = 20ms; $t(120) = 2.64$, $p = .009$, $d = 0.479$) (Figure 5.5b).

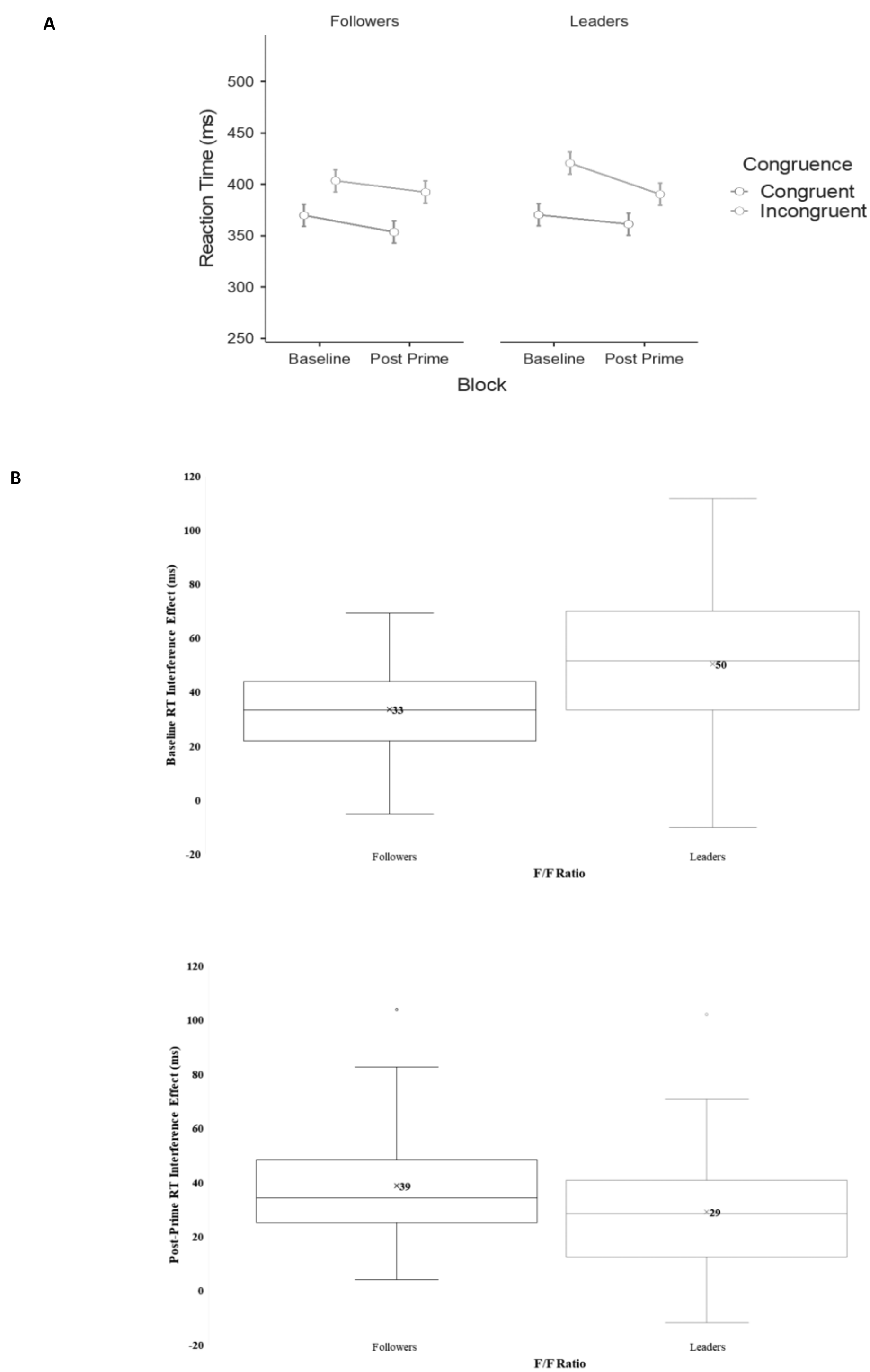


Figure 5.5 (A) Three-way interaction (block x congruence x f/f ratio) showing how block x congruence interaction differs for followers and leaders. Error bars are 95% CI – see text for statistics. (B) RT interference effect for followers versus leaders during the baseline and post-prime block.

Error Rate (ER) Analysis: Comparing Instagram Leaders and Followers

For the ER analysis, we conducted a 2x2x2 mixed ANOVA, with two within-subject factors: (Congruency: Congruent, Incongruent) & (Block: Baseline, Post-Prime) and one between-subjects factor (F/F Ratio: Follower, Leader). This analysis revealed a significant main effect of congruency $F(1, 120) = 242.85$, $p < 0.001$, $\eta^2p = 0.669$. However, no main effect of block $F(1, 120) = 2.81$, $p = 0.096$ or any significant interactions were found ($p > 0.05$).

Correlations between f/f ratio and perceived online status

Similar to Experiment 1, there was a positive correlation between perceived online status and the f/f ratio, $r = .219$, $n = 122$, $p = .01$).

Regression Analyses

Relationship between f/f ratio and baseline RT interference

Regression analysis was run (i.e., treating the f/f ratio as a continuous variable) to determine whether differences in the f/f ratio predicted differences in RT interference. The f/f ratio did not predict baseline RT interference, $\beta = 7.24$, $t(120) = 1.78$, $p = .078$.

Relationship between f/f ratio and post-prime RT interference

A second regression analysis was conducted to determine whether differences in the f/f ratio predicted differences in post-prime RT interference. The f/f ratio significantly predicted post-prime RT interference, $\beta = -7.74$, $t(120) = -2.17$, $p = .032$, $R^2 = .038$ (See Figure 5.6).

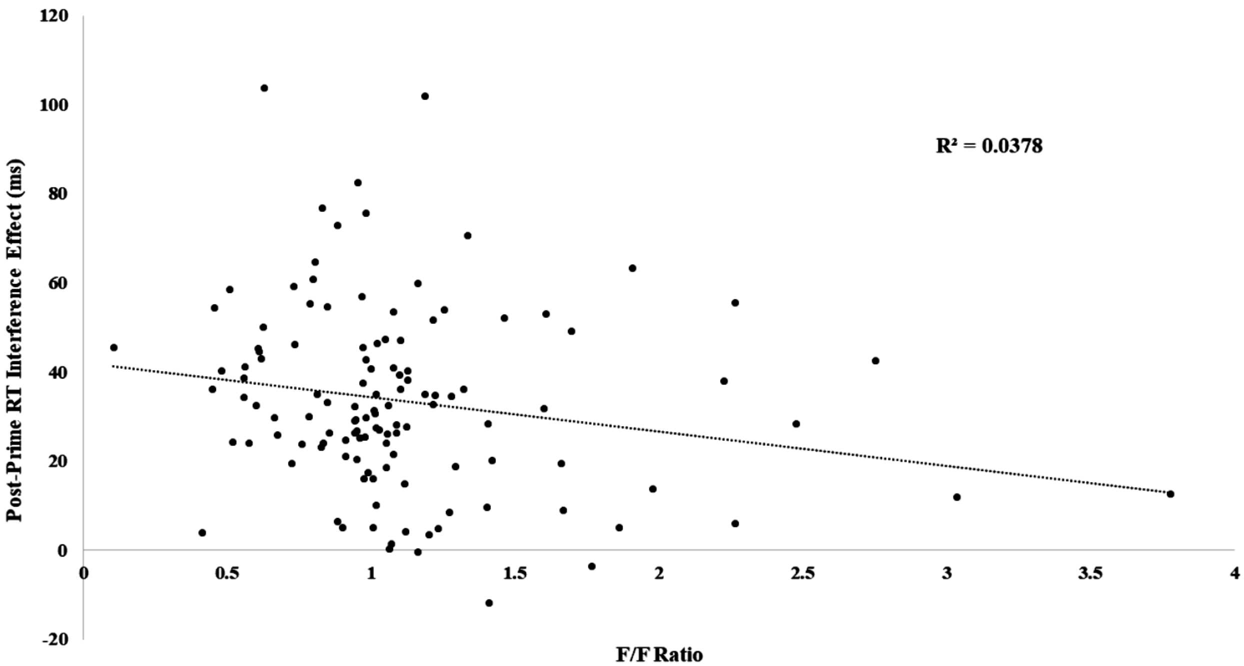


Figure 5.6 There was a linear relationship between the follower/following ratio and automatic imitation, with higher f/f ratios significantly predicting the degree of post-prime RT interference (i.e., incongruent RT – congruent RT).

Relationship between f/f ratio and baseline ER interference

We ran a third regression analysis to determine whether differences in the f/f ratio predict differences in baseline ER interference. The regression was not significant, $\beta = -.104$, $t(120) = -.110$, $p = .913$.

Relationship between f/f ratio and post-prime ER interference

A final regression analysis was conducted to determine whether differences in the f/f ratio predict differences in post-prime ER interference. The regression was not significant, $\beta = .373$, $t(120) = .278$, $p = .781$.

5.5.3 Experiment 2 Discussion

To address whether the effects in Experiment 1 depended on being reminded of online status or whether they were "prime independent", Experiment 2 incorporated a baseline and post-prime AIT session with a much larger sample size. Results revealed that the effects of online status become apparent when the f/f ratio (online status) is made salient prior to the experimental task. Specifically, priming-induced changes in the RT interference effect occurred in opposite directions for leaders and followers. After priming, leaders showed significantly less interference and followers showed significantly more interference, relative to their respective baseline levels. To be clear, if the mere fact of having a higher online status affected automatic imitation, we should have observed a pattern in which RT interference was greater for followers compared to leaders in the baseline condition. The fact that we only observed this pattern after priming shows that explicitly thinking about status may be necessary for effects on imitative processing to emerge. In line with this finding was the observation that f/f ratio significantly predicted RT interference only in the post-prime condition in a negative fashion, such that higher levels of f/f ratio predicted lower levels of RT interference. Finally, in accordance with Experiment 1, we again found a significant correlation between the f/f ratio and perceived online status, although it was weaker. The issue of whether the apparent requirement for status being salient diminishes the impact of our findings is important. We suggest that in the social media context when users interact with their accounts, their relative status is indeed salient. Future experiments in which varying levels of status priming (e.g., simple signing into Instagram vs. reflecting on f/f ratio) are compared will help establish the minimum conditions under which the effects we report manifest.

5.6 General Discussion

In two experiments, we found that priming online status in the context of the ratio of followers to people being followed on Instagram affected the degree to which people automatically imitated an observed movement. Given that automatic imitation in this task is thought to index the automatic activation of an "other related" motor representation, these results have implications for how thinking about online status affects what has been termed "self-other" processing. Extant literature suggests that the automatic imitation task taps into self-other control, in that an individual is required to exert control over activated representations that pertain to the self or another individual. Specifically, the on-screen movement is an "other-related" cue that automatically activates a corresponding motor representation in the observer's brain. In contrast, the participant attempts to implement a "self-related" action in response to an external numeric cue. The extent to which the participant is able to deal with the conflict induced by simultaneously activated self and other representations reflects self-other processing (e.g., Santiesteban et al., 2012; Hogeveen & Obhi, 2013).

Our results suggest that Instagram followers are more susceptible to "other" activated processes compared to Instagram leaders, at least when thoughts of their status have recently been activated. In contrast, high status individuals show reduced automatic imitation after they've been reminded of their status. Such reduced sensitivity to the "other" in high status individuals could, in real-life, partially explain the interactive behavior of some users of social networking sites (DeAndrea & Walther, 2011). Indeed, previous work has shown that lower ranking individuals may focus their attention more on social stimuli, since they typically rely on others for positive social outcomes (Fiske, 1993; Keltner et al., 2003). However, another explanation could be that Instagram followers and leaders differ in their ability to inhibit task-irrelevant actions during incongruent trials. Indeed, previous work has found a negative relationship between one's level of social rank and their susceptibility to distraction by irrelevant stimuli (Guinote, 2007, 2008). It is also possible that that both processes may have played a role in our findings. Relatedly, other work has also shown that high rank individuals can sometimes be more interpersonally sensitive than their low rank counterparts (Schmid-Mast et al., 2009). Future studies are needed to distinguish between competing explanations for the pattern of data we report here, and to more fully understand when and how high and low rank states modulate social attunement.

In addition to status, other social moderator variables have been linked to differences in automatic imitation. Specifically, the interference effect has been shown to be sensitive to differences in sub-clinical narcissism, pro-social mindset, and self-focus (e.g., Spengler et al., 2010; Cook & Bird, 2011; Obhi et al, 2014). However, there is still some debate on whether and how automatic imitation is modulated by social factors or even underlies any social phenomenon (see Genschow et al., 2017; Ramsey, 2018; Cracco & Brass, 2019). The current results (at least in conditions wherein individuals are reminded of their relative status) fit well with previous reports that high rank individuals do not necessarily pay careful attention to others, whereas low rank individuals do pay careful attention to others (Erber & Fiske, 1984; Ellyson & Dovidio, 1985; Fiske, 1993).

The current results are also in line with recent studies that have focused on examining the relationship between real life status and motor resonant processes as indexed via measures such as Mu-suppression calculated from EEG data (Varnum et al., 2016). Given that differences in motor resonance have been linked to differences in status (Varnum et al., 2016), it is surprising that very few studies have begun to address the question of whether a person's online status and offline status are concordant or dissimilar in terms of their effect on motor resonance. An important question for future work is whether online status and offline status always exert similar effects (within participants) on a host of other social cognitive processes, of which automatic imitative processing is but one example. It might be expected for example, that online status decays rapidly after leaving the online context, or that real-life status overrides online status in real world interaction but not in online interactions.

Limitations

Even though we argue that the Instagram f/f ratio can be used as a status manipulation, we should also consider other potential explanations for the effects we observed. One possibility could be that people with many followers have more followers because they are more active on Instagram and post more often; logging into Instagram might be self-affirmative for this group (see Toma & Hancock (2013) for Facebook) but less so for the others that might use Instagram mainly for passively following others. As such, future work is encouraged to control for the frequency of active/passive use or self-esteem in order to further elucidate on this effect.

In addition, although the findings of this study suggest that the differences in automatic imitation are linked to differences in online status, it is also possible that these downstream effects are due to other factors. Indeed, it could be argued that similar results may have been observed by having participants view a fake high rank Instagram profile (many "followers" compared to how many people they are "following") versus a fake low rank Instagram profile (few "followers", compared to how many people they are "following"). However, we argue that many social media users are heavily invested in building their online presence based on previous work (Kim, Wang, & Oh, 2016), and as a result, reminding them of their personal social rank on the platform may be more powerful than simply circling a larger number from a fake account. Nevertheless, this is an interesting question that should be examined further.

In addition, the demographics of the sample may also lead to important limitations to the generalizability of these results to older age groups. More specifically, all the participants in this study were undergraduate students between the ages of 18 – 25, with birth years between 1995 to 2002 (Generation Z). Indeed, previous work has shown that individuals from Generation Z are exposed to social media more than anything else in their daily lives, coming second only to sleep (Turner, 2015). As a result, they may have been more susceptible to the effects of social media use compared to other age groups (millennials, Generation X, etc.). This has important implications for the generalizability of this study's findings, as older generations may not be as sensitive to manipulations of online status compared to their Generation Z counterparts. However, future work is needed to explore this question. In addition, it is also important to note that other factors such as ethnicity or gender were not considered in this study. These factors could have contributed to differences in performance on the automatic imitation task. Therefore, future work is encouraged to design experiments to test these possibilities.

We have shown that there is a negative relationship between an individual's Instagram f/f ratio and their RT interference effect during the AIT, and that this effect depends on participants having recently thought about their online status. Given that interference in this task is thought to index automatic imitative behaviour, our findings indicate that differences in online status are linked to differences in the tendency to imitate the actions of another individual. By extension, this may highlight differences between high and low status individuals in their levels of self-other processing (Santiesteban et al., 2012). Indeed, the degree of automatic imitation is thought to index self-other control processes, and our results suggest that this control process is affected when individuals think about their online status, such that individuals who are high in online status are less impacted by the actions of others when performing a self-related action. Our work also opens up a new question about the downstream effects of online status versus real-life status (e.g., when they differ and when they match) on a host of other social cognitive processes.

Chapter 6

The effects of online status on social mimicry in a virtual setting

Farwaha, S., & Obhi, S. (In Prep.). The effects of online status on social mimicry in a virtual setting.

6.1 Preface

Since previous chapters have shown that online status modulates motor resonance using both physiological and behavioural methods, this chapter focuses on extending this line of research beyond traditional laboratory-controlled conditions. In the study presented in this chapter, undergraduate participants interact with a confederate that either has a larger or smaller Instagram following than them via ZOOM (online video conferencing platform). During the online interaction, the confederate performed face-touching actions every 10 seconds. Overall, we found that participants that had fewer Instagram followers than the confederate exhibited greater mimicry behaviour during the online interaction compared to when they had more Instagram followers than the confederate. This result is in line with the work conducted in previous chapters, which found that low online status individuals exhibited greater motor resonance during action observation compared to their high online status counterparts in a laboratory setting. This is the first study to examine how online status modulates mimicry behaviour during a virtual interaction via ZOOM. The implications of these findings are discussed further in the chapter.

6.2 Abstract

High ranking individuals have been found to be less attuned to the behaviour of others in the social environment. In the modern world, social networks such as Instagram afford new forms of social status hierarchy. An important unanswered question is whether online status will modulate an individual's mimicry behaviour beyond traditional laboratory-controlled conditions, such as an online interaction via ZOOM. In this study, we examined differences in social mimicry between Instagram 'leaders' and 'followers'. We defined Instagram leaders as individuals who have more followers than their interaction partner and Instagram followers as individuals who have fewer followers than their interaction partner. We found that followers exhibited greater social mimicry during a virtual interaction via ZOOM than leaders. Overall, our findings suggest that differences in online status are linked to differences in social mimicry.

6.3 Introduction

For most of human history, social interactions have occurred between people near one another. One prominent feature of these social interactions is that they reflect the presence of status hierarchies, including the associated thoughts and behaviours of those at the top of these hierarchies relative to those at the bottom (Graf et al., 2012; Maner & Menzel, 2013; Keltner & Cordaro, 2017). Extant literature in social psychology has examined the link between status (and the related construct of power) and social cognition (Fiske, 1993;

Keltner et al., 2003; Smith & Trope, 2006; van Kleef et al., 2008). Indeed, previous work has suggested that since powerful individuals have relatively unrestricted control and access to valued resources, they may be less attentive to subordinates (Fiske, 1993; Foerster et al., 2005) and exhibit less interpersonal sensitivity during action observation (Hogeveen et al., 2014; Varnum et al., 2016). This is in stark contrast to powerless individuals, who devote much of their attention to high-ranking others since they control their valued social, economic, and physical outcomes (Keltner et al., 2003). As such, the differences between the people at the top and at the bottom of the socioeconomic ladder can have clear downstream effects on social information processing.

Importantly, in the 21st century, many social interactions have moved away from face-to-face interaction and towards online video conferencing and social media platforms. This is especially apparent during the COVID-19 pandemic, where lockdowns and stay at home orders have increased the demand for platforms such as ZOOM to conduct business, attend important meetings, and stay connected with friends and family. Since the start of the COVID-19 pandemic, the daily meeting participants on this platform has averaged around 300 million worldwide (Wiederhold, 2020). Social interactions on ZOOM are quite distinct from traditional human interactions, in that they allow people to stay connected to individuals who can sometimes be multiple time zones apart. Of course, one limitation of these video conferencing platforms is that they are not always completely synchronous, and users typically experience short delays in communication (Wiederhold, 2020; Bailenson, 2021).

In addition to the use of video conferencing platforms, people have also moved towards using social media platforms to stay connected with friends and family. One of the most popular social media platforms on the internet is Instagram. On this platform, individuals can share their personal photos and videos with anyone that has access to their profile (if their account is private) or anyone with an account on the platform (if their account is public). In this study, we focused primarily on the social hierarchy at play on Instagram, which is reflected by statistics such as the number of people following an individual's profile versus the number of profiles that that individual follows. In general, Instagram users with a larger Instagram following tend to have greater social ranking on the platform compared to users with a lower Instagram following (McCain & Campbell, 2016; Sherman et al., 2016; Konstantopoulou et al., 2019). Nonetheless, given the huge popularity and need for platforms such as Instagram and ZOOM during the global pandemic, it is important to explore whether online social hierarchies have similar behavioural effects on social cognitive processes (beyond laboratory-controlled conditions) such as mimicry, compared to previously documented effects of real-world social hierarchies (Cheng & Chartand, 2003).

Social mimicry, also referred to as the Chameleon Effect (Chartrand and Bargh, 1999), refers to phenomena where individuals tend to copy the actions of another during a social interaction. Mimicry is coded when this behaviour occurs within seconds of the original movement. In their seminal paper, Chartrand and Bargh (1999) found that when confederates performed actions such as face touches, participants tended to mimic their behaviour significantly more compared to participants in a neutral group. It has been argued that motor resonance is the mechanism that underlies social mimicry (Hogeveen & Obhi, 2012). Motor resonance is classified as motor activity that occurs during action observation in the absence of action execution. The link between motor resonance and behavioural mimicry has been supported by Hogeveen and Obhi (2012), who demonstrated that social interactions with others modulate the motor resonance system. Indeed, they found that individuals that were mimicked during a social interaction exhibited greater motor-evoked potentials (MEPs) via transcranial magnetic stimulation (TMS) during action observation compared to those that were not mimicked. Since motor resonance has been linked to social capacities such as empathy, other work has also supported that it may play an important role in maintaining healthy relationships and rapport with others (Lakin et al., 2003; Lakin & Chartrand, 2003). Furthermore, it has also been found that high self-monitors (individuals who exert significant control over their own public image based on social cues available in their social environment) exhibit greater mimicry behaviour when interacting with a powerful peer, compared to low self-monitors (Cheng & Chartrand, 2003).

Previous work has also examined how power and status may modulate the motor resonance system. For example, Hogeveen et al. (2014) found reduced MEP facilitation (via transcranial magnetic stimulation) for a group primed to high power (through an essay priming technique) compared to a low power group. Similarly, Varnum and colleagues (2016) found stronger Mu-suppression (via electroencephalogram) during action observation for a low socioeconomic (SES) group compared to a high SES group. The current study is inspired by these demonstrated effects of social rank on interpersonal sensitivity and investigated how these factors may modulate social mimicry. However, instead of observing in-person interactions, we have moved towards examining social interactions in an online setting such as ZOOM.

Typical mimicry studies examine in-person interactions between an individual and a confederate (who is asked to perform specific actions during the interaction). These interactions usually revolve around a task unrelated to mimicry (such as the "photo description task") in order to prevent suspicion of the participants with regard to the true purpose of the study (Chartrand & Bargh, 1999). These interactions are covertly recorded and coded for mimicry behaviour by independent coders. However, no study to our knowledge has explored whether social mimicry occurs during interactions in an online setting (such as ZOOM) or examined how differences in online status between a participant and their interaction partner might modulate the mimicry behaviour exhibited by the participant. In the current study, we had a confederate interact with a participant via ZOOM. Participants were told that they would be asked some general questions about their Instagram user experience. Before the session, participants were asked to write down their Instagram followers as their screen name and were told that this information would be used for a subsequent task. However, no subsequent task was conducted in this study. In order to manipulate online status, the confederate would have either more or less followers than the participant. We hypothesized that Instagram "leaders" (participants that had greater online rank than the confederate) would display less mimicry during the interaction, compared to Instagram "followers" (participants that had weaker online rank than the confederate) based on the findings from previous studies in the field (Cheng & Chartrand, 2003; Hogeveen & Obhi, 2014; Varnum et al., 2016). We also predicted a negative linear relationship between one's perceived online status during the session (relative to their interaction partner) and their mimicry behaviour.

6.4 Methods

6.4.1 Participants

One hundred and six volunteers (17 males, 88 females, 1 non-binary; Mean age = 18.34 years of age, *SD* = 0.81) participated in this study for course credit. Participants were recruited from McMaster University's Psychology, Neuroscience and Behaviour Research Participation System. All participants were right-handed and had normal or corrected-to-normal vision. Most importantly, all participants were naïve with respect to the purpose of the experiment. The study was approved by the McMaster University Research Ethics Board (MREB) and participants provided informed consent before participation.

6.4.2 Procedure

The experiment took place over ZOOM (San Jose, CA). Participants were told that they would be asked about their user experience on Instagram during a one-on-one video conference call (See Figure 6.3) and that this virtual interaction would be recorded for the purpose of data collection. Importantly, before entering the ZOOM session, participants were asked to be alone in a quiet area where they would not be interrupted by others during their ZOOM session.

During the virtual interaction, the participant was asked to hide their self view on ZOOM, so that they could not see themselves during the entire session. In addition, participants were asked to login to their Instagram account, write down how many followers they had, and include that information as their ZOOM screen name. Participants were told that this information would be used for a subsequent Instagram task, even though there was no additional task after the interview. Importantly, the participants were randomly assigned to one of two conditions: 1) follower condition and 2) leader condition. In the follower condition, the confederate would write "followers = 3000" as their ZOOM screen name. In this condition, the confederate would have more followers than the participants, resulting in them being in a lower status condition (also referred to as Instagram followers). In the leader condition, the confederate would write "followers = 100" as their ZOOM screen name. In this condition, the confederate would have fewer followers than the participant, resulting in them being in a higher status condition (also referred to as Instagram leaders). If these conditions were not met for any reason during the session (participant's followers > 3000 or participant's followers < 100), the participant was excluded from the analysis. Importantly, no participants had to be excluded from the analysis based on this criterion.

During the session. participants were asked a range of questions about their Instagram user experience (see Figure 6.3). Crucially, during the interaction, the confederate performed face-touching actions every 10 seconds using the same hand. After all the questions about their Instagram user experience were answered by participants (see Figure 6.3), the recording was stopped, and the confederate asked the participants the following three questions during the debrief interview: 1) Did anything stand out to you during the experiment? 2) What do you think the purpose of the experiment was? 3) Did you recognize anyone that you might know in this experiment? These questions are used in social mimicry studies to ensure that the participant is not suspicious of the true purpose, which could influence their natural behaviour during the session. If a participant suspected deception, they were excluded from the analysis. Importantly, no participants had to be excluded from the analysis based on this criterion.

Once participants completed the debrief interview, they were asked to complete an online survey asking them general questions about their demographic background, their level of anxiety during the session from 1 (no anxiety) to 10 (significant anxiety), and their perceived online status relative to their interaction partner from 1 (low status) to 10 (high status). Importantly, the experimenter was not present at all while participants completed this form and did not access the form until after the study was completed.

6.5 Results

6.5.1 Data Analysis

The dependent measure in this experiment was the mimicry ratio (s). The mimicry ratio was used as an index of a participant's mimicry behaviour (face-touching actions) during the interaction and was calculated by dividing the interaction ratio by the baseline ratio. The interaction ratio reflected how much time the participant spent touching their face during the interaction divided by the total interaction time. The baseline ratio reflected how much time the participant spent touching their face during a randomly selected 1-minute period (using a random number generator) during the interaction. Two independent raters examined the video sessions and coded face-touching behaviour for all the participants in this experiment. The mimicry ratio has been used by previous studies that examined differences in social mimicry between groups (Hogeveen & Obhi, 2012), as it more precisely quantifies mimicry behaviour by examining the amount of time the participant spent mimicking the target face-touching action rather than the number of times they mimicked the action throughout the session. A high mimicry ratio indicates that a participant exhibited greater mimicry behaviour during the interaction (relative to their baseline) compared to a participant with a low mimicry ratio. To examine differences in mimicry ratio associated with varying degrees of online status, the sample was split into an Instagram follower condition (confederate’s follower count > participant’s follower count) and an Instagram leader condition (confederate’s follower count < participant’s follower count).

6.5.2 Range of Perceived Online Status and Anxiety

Our sample consisted of 55 Instagram followers (consisting of 55 females) and 51 Instagram leaders (consisting of 33 females, 17 males, and 1 non-binary participant). Perceptions of online status relative to their interaction partner ranged from 1 (low status) to 10 (high status) (M = 4.82, SD = 1.62). In addition, participants’ level of anxiety experienced during the session ranged from 1 (no anxiety) to 10 (high anxiety) (M = 2.87, SD = 1.84). All inferential statistical analysis was performed with JAMOVI (Version 1.6). In addition, all assumptions for the independent samples t-test were met.

6.5.3 Mimicry Ratio Analysis: Comparing Leaders and Followers

To examine differences in social mimicry between followers and leaders, an independent samples *t*-test was conducted. We found that the mimicry ratio during the ZOOM interaction was significantly greater for followers (M = 0.55, SEM = 0.12) compared to leaders (M = 0.23, SEM = 0.09; $t(104) = 2.28$, $p < 0.05$, d = 0.443; See Figure 6.1)[1].

6.5.4 Regression Analysis

6.5.4.1 Relationship between Perceived Online Status and Mimicry Behaviour

Treating perceived online status as a continuous variable, we ran a regression analysis to determine whether differences in one's perceived online status (relative to their interaction partner) predicted differences in mimicry behaviour. This analysis revealed that perceived online status significantly predicted mimicry ratio, $\beta = -0.109$, $t(104) = -2.49$, $p < 0.05$, $R^2 = .056$ (See Figure 6.2).

6.5.5 ZOOM Video Coding

The ZOOM sessions were coded and scored for baseline ratio and interaction ratio by two independent coders, which were used to calculate participants' overall mimicry ratio. The judgements of the independent raters were reliably correlated for the baseline ratio (r = 1.00, $p < 0.001$) and interaction ratio (r = 0.98, $p < 0.001$).

[1]In order to ensure that differences in social mimicry between Instagram leaders and follower were not due to differences in anxiety during the interview, we also compared the participants' level of anxiety during the session. This test revealed no difference in anxiety levels between followers (M = 3.0, SEM = 0.25) and leaders (M = 2.7, SEM = 0.26; $t(104) = 0.874$, p = 0.384.

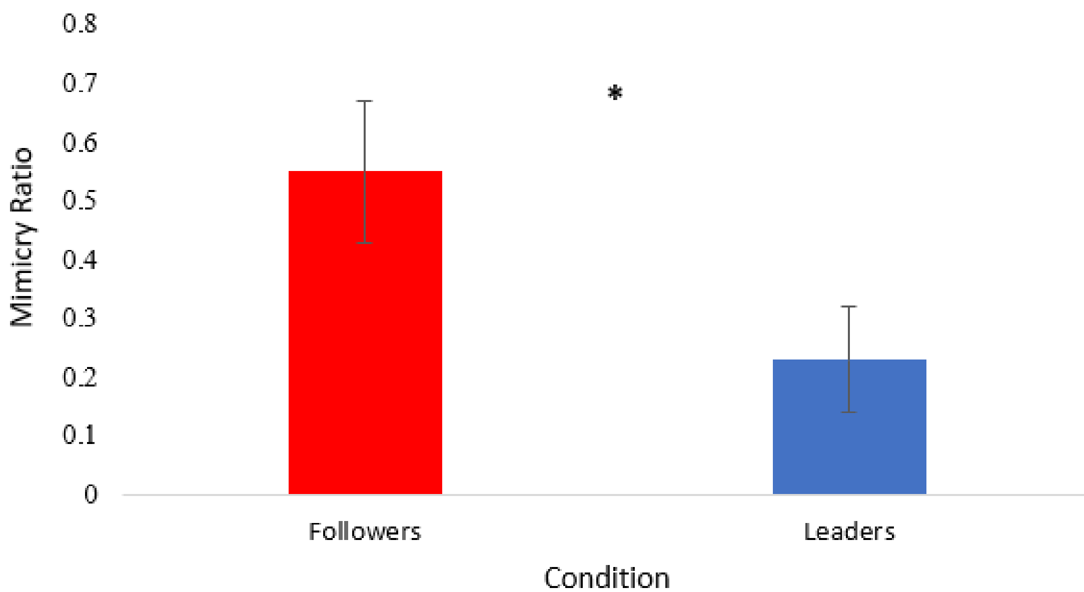


Figure 6.1 The size of mimicry ratio was significantly greater for the follower group relative to the leader group during the ZOOM session. * Significant at α = 0.05, ** significant at α = 0.01. Error bars indicate SEM.

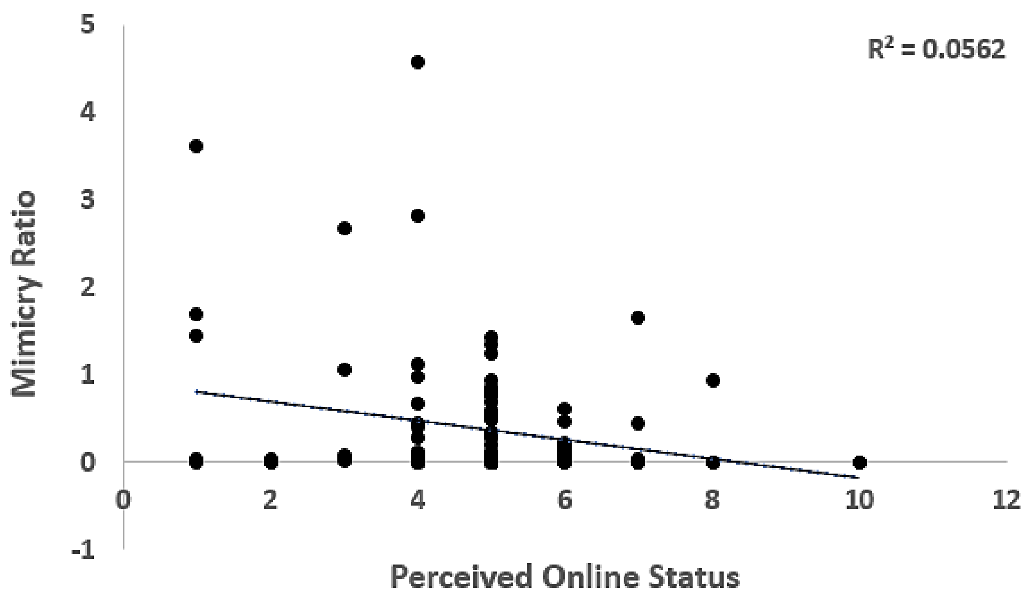


Figure 6.2 There was a negative relationship between perceived online status and mimicry behaviour.

1) Information about you: Your age now? Year of study? Program you are enrolled in?

2) Please tell me about your Instagram profile – When did you create it? How many posts have you made in total? Is your profile public or private?

3) How would you describe Instagram to someone who is not familiar with the platform?

4) Do you think Instagram has shaped social interactions between people? Please expand on your answer.

5) In your opinion, what are some of the benefits that Instagram brings to society?

6) In your opinion, what are some concerns that people have about Instagram?

7) How has Instagram shaped or influenced your life since you have started using it?

8) How long have you used Instagram for?

9) On a regular day, how often do you check your Instagram?

10) Is there something important we forgot? Is there anything else you think I need to know about Instagram or the user experience?

END

Figure 6.3 Questions asked by the confederate to the participant about their Instagram user experience.

6.6 Discussion

In this study, we found that Instagram leaders (participants that had more followers than the confederate) mimicked the confederate's targeted actions significantly less compared to Instagram followers (participants that had fewer followers than the confederate). This finding is the first to our knowledge that supports that social mimicry can be modulated by the online social hierarchy on Instagram. In addition, we also found that there was a significant negative linear relationship between one's perceived online status (relative to their interaction partner) during the ZOOM session and their mimicry behaviour.

The current results fit well with previous reports that suggest that individuals who are at the top of the socioeconomic ladder may not be as attentive or socially attuned to others compared to their lower status counterparts (Erber & Fiske, 1984; Ellyson & Dovidio, 1985; Fiske, 1993; Hogeveen et al., 2014; Varnum et al., 2016). Indeed, our findings also provide a behavioural extension to the physiological work conducted by Hogeveen and Obhi (2012), which examined the link between mimicry and motor resonance using motor-evoked potentials (MEPs) via transcranial magnetic stimulation (TMS). Importantly, they found that individuals who mimicked others during a social interaction exhibited greater MEP facilitation during a subsequent action observation task compared to individuals that did not mimic others.

Our results also fit with the findings of recent studies examining the link between real life status and power and motor resonant processes, as indexed by electroencephalogram (EEG) and transcranial magnetic stimulation (TMS) (Hogeveen et al, 2014; Varnum et al., 2016). In their study, Varnum and colleagues (2016) found stronger Mu-suppression during action observation for a low SES group compared to a high SES group. Similarly, Hogeveen et al. (2014) found reduced MEP facilitation during action observation for a high power group compared to a low power group. Even though these differences in motor resonance have been linked to varying levels of power and status (Hogeveen et al., 2014; Varnum et al., 2016), there are very few studies that have begun to address the question of whether one's online status and offline status (real-world) have similar downstream effects on motor resonance. As such, future work should examine whether these factors also modulate other closely related social cognitive processes, such as empathy or perspective-taking.

Our results suggest that Instagram followers are more sensitive and indeed more responsive to the actions of others compared to Instagram leaders, at least when thoughts of their status relative to their interaction partner during the ZOOM call have been activated. The finding that high status individuals exhibit reduced interpersonal sensitivity to others is also supported by previous research on attention (Fiske, 1993; Keltner et al., 2003). However, there still remains some debate about these findings, as other work has suggested that high ranking people tend to be more attuned to others compared to their low ranking counterparts (Schmid-Mast et al., 2009). As such, we recommend that researchers assess both of these possibilities in order to establish how high versus low online status may modulate interpersonal sensitivity. Even though we explored how online status may modulate social mimicry, there has been a significant amount of other work that has examined the link between various social factors and mimicry behaviour. For example, it has been shown that an individual tends to exhibit greater behavioural mimicry with a friend compared to when they interact with a stranger (McIntosh, 2006). In addition, it has also been found that ingroup members tend to mimic each other more during social interaction compared to when they interact with outgroup members (Bourgeois & Hess, 2008). It has also been found that when individuals have a goal to affiliate with another, they tend to mimic them more often (Lakin and Chartrand, 2003). As such, it is evident that the mere desire to be associated with someone leads to greater behavioural mimicry.

Furthermore, it has also been found that high self-monitors exhibit greater mimicry behaviour when interacting with a powerful peer compared to low self-monitors (Cheng & Chartrand, 2003). Future work should explore how other online social factors such as popularity on social media or feelings of social exclusion online (indexed via self-report measures) might modulate social mimicry during interaction.

Limitations

Even though our findings are the first to show that online status modulates social mimicry during an online interaction, we must also consider the limitations of our study. First, the demographics of the sample limit the generalizability of these results to older age groups. The participants in this study were undergraduate students between the ages of 18 to 25 (Generation Z). Indeed, previous work has shown that Generation Z consume social media more than they watch television or participate in other online activities (Turner, 2015). As a result, they may have been more susceptible to this status manipulation compared to millennials or Generation X. However, future work is needed to explore this question. Second, it is also important to note that other factors such as ethnicity or gender were not considered in this study. These factors could have contributed to differences in behavioural mimicry during the virtual interaction, especially since researchers have found a link between behavioural mimicry and ingroup bias (Bourgeois & Hess, 2008). Therefore, future work is encouraged to design experiments to test these possibilities. Another important factor that was not considered in this study was ZOOM fatigue. Many researchers argue that the overuse of video conferencing tools may lead to significant fatigue or tiredness, especially since ZOOM has now been used for attending daily meetings and classes for many (Wiederhold, 2020; Bailenson, 2021). Since all the participants in this study were undergraduate students, the potential for ZOOM-based fatigue may have played a role in dictating their behaviour or alertness during the interaction. Future work should account for this factor by examining how much time participants typically spend on ZOOM throughout the week via self-report measures. In addition, other related work suggests that these technologies, while useful for daily activities involving social distancing, are not completely synchronous; there is a slight delay between when an individual performs an action and when their interaction partner observes it (Wiederhold, 2020; Bailenson, 2021). As a result, this disruption of natural synchrony may pose issues to some participants during virtual mimicry studies compared to others (Wiederhold, 2020; Bailenson, 2021). Future work should explore this possibility through empirical studies examining the similarities and differences between in-person and online interactions via ZOOM. Finally, it is still unclear whether the difference in mimicry behaviour observed between groups was due to their relative difference in followers compared to the confederate or whether the specific number of followers the confederate displayed on-screen (followers = 3000 vs. followers = 100) facilitated this effect. Future empirical work is required to address this question.

In conclusion, we have shown that there is a negative linear relationship between an individual's Instagram status and their mimicry behaviour during a virtual interaction. Previous studies have explored social mimicry behaviour during in-person interactions within a laboratory environment, however, no study to our knowledge has explored this behaviour in an online setting such as ZOOM. Overall, the findings of this study provide evidence in favour of the idea that our online status and offline status may be concordant in terms of their effect on interpersonal resonance. In addition, our work also introduces new questions about the potential concordance between online and offline status on a host of other social cognitive processes.

Chapter 7

General Discussion

7.1 Introduction

The aim of this dissertation is to corroborate and extend on previous physiological work in the field and begin to explore whether online status has similar downstream effects on motor resonance compared to previously documented effects of offline (real-world) status. Chapters 2-3 corroborate and extend the findings of previous physiological studies that suggest SES and social power modulate the motor resonance system. Chapters 4-6 begin to explore whether the effects of online social hierarchy are concordant with the effects of offline (real-world) social hierarchy on the motor resonance system using a variety of physiological and behavioural methods. In this general discussion chapter, I will discuss the important contributions and limitations of Chapters 2-6 (section 7.2), provide a summary of the overall results (section 7.3), suggest future avenues of research that would extend my findings (section 7.4), explore issues concerning automatic imitation (section 7.5) and self-other distinction (section 7.6), and finally, conclude this dissertation (section 7.7).

7.2 Important Contributions and Limitations of Each Chapter

7.2.1 Chapter 2

Varnum et al. (2016) previously found that socioeconomic status modulates interpersonal sensitivity, as indexed by Mu-suppression via EEG. Specifically, they found that low SES participants showed stronger Mu-suppression during action observation compared to their high SES counterparts. As such, the study presented in this chapter extended on this work by examining how SES modulates automatic imitation (a behavioural index of motor resonance). However, instead of using an undergraduate sample, adults over the age of 30 were recruited from the local community in order to increase the generalizability of the findings. We found that low SES individuals showed significantly greater interference effect on the AIT compared to their high SES peers. This result is in line with previous findings from physiological studies showing that increasing levels of socioeconomic status are associated with decreasing levels of motor resonance during action observation (Varnum et al., 2016). In addition, these findings also suggest that these downstream behavioural effects are generalizable to adults over the age of 30 from the local community.

There are two major limitations of this study. First, factors such as ethnicity, IQ, and anxiety levels of the participants were not considered in this study. It is possible that these factors may have contributed to differences in performance during the automatic imitation task. As such, researchers in the field are encouraged to follow up with this question through additional empirical studies. Second, although the aim of this study was to extend on the findings reported by Varnum and colleagues (2016), there is still some debate on whether Mu-suppression is linked to motor resonance during action observation in the literature (Coll et al., 2015; Hobson & Bishop, 2016; Coll et al., 2017). Thus, researchers are encouraged to further investigate whether Mu-suppression is a valid physiological index of sensorimotor resonance in the future.

7.2.2 Chapter 3

Hogeveen et al. (2014) previously found that social power modulates motor resonance, as indexed by TMS-induced motor-evoked potentials. Specifically, they found that individuals who were primed to a high power condition exhibited reduced motor resonance during action observation compared to individuals who were primed to a low power condition. A similar pattern of results was found when examining how SES modulates motor resonance during action observation (as indexed by Mu-suppression via EEG) (Varnum et al., 2016). Since the findings of Varnum and colleagues (2016) were extended using the automatic imitation task in Chapter 2, this chapter begins to explore how priming low and high SES participants to varying levels of social power may modulate automatic imitation. Our findings indicate that priming participants did not differentially modulate automatic imitation. However, we did find that both high SES and high power participants exhibited a significantly lower interference effect during the AIT compared to individuals of low SES and low power. This result supports previous findings from physiological studies showing that increasing levels of socioeconomic status and social power are associated with decreasing levels of motor resonance during action observation (Hogeveen et al., 2014; Varnum et al., 2016). In addition, these findings also suggest that these downstream behavioural effects are generalizable to adults over the age of 30 from the local community.

There are two major limitations of this study. First, this study relied solely on using power priming essays to manipulate situational power. As such, future work should explore the effects of other power priming techniques that could be applied to manipulate situational power more realistically, such as assigning participants to a “supervisor” or “employee” role during an unrelated task before they complete the AIT. Second, it is also possible that the automatic imitation task may not be sensitive enough to capture an interaction between power and SES. As such, researchers in the field are encouraged to use physiological tools such as TMS (Hogeveen et al., 2014) or EEG (Varnum et al., 2016) to investigate this question further.

7.2.3 Chapter 4

Previous physiological work has found that both SES and social power modulate motor resonance during action observation (Hogeveen et al., 2014; Varnum et al., 2016). In Chapters 2 and 3, this physiological work was extended behaviourally using the AIT. However, no previous work has considered the changing dynamic of social interactions in the 21st century. Indeed, these changing dynamics have led to new forms of online social hierarchy. As such, this chapter explores how online status modulates motor cortical output during action observation, as indexed by TMS-induced motor-evoked potentials. Our findings suggest that Instagram followers exhibited greater MEP facilitation during action observation compared to Instagram leaders. A similar pattern of results was found by previous physiological work examining how offline status and power modulate motor resonance during action observation (Hogeveen et al., 2014; Varnum et al., 2016). These findings suggest that online and offline (real-world) social rank exert concordant effects on motor cortical output. Naturally, this work also raises new questions about the effects of online status versus offline status on a host of other social cognitive processes.

There are two major limitations of this study. First, the discussion was limited to motor cortical output rather than motor resonance since there was a lack of muscle specificity during the action observation task. As such, future studies are encouraged to address this issue by including a control muscle unrelated to the action in question during the task. Second, since only one baseline block was used before the action observation block, it is unclear whether there were any potential drifts in motor cortical excitability across the experiment. As such, future work should incorporate a baseline block before and after the action observation block to allow for a more definitive interpretation of the findings.

7.2.4 Chapter 5

The studies presented in this chapter aimed to directly extend and corroborate the findings from Chapter 4, by exploring how online status modulates automatic imitation (a behavioural index of motor resonance). Across two experiments, we found that Instagram followers showed significantly greater interference effect on the AIT compared to Instagram leaders, at least when their relative status was highlighted before the task. This result supports previous findings from physiological studies showing that as levels of status and power increase, motor resonance during action observation decreases (Hogeveen et al., 2014; Varnum et al., 2016). Furthermore, these findings also suggest that online and offline (real-world) social rank exert concordant effects on automatic imitation. Naturally, this work also raises new questions about the effects of online status on a host of other social cognitive processes.

There are two major limitations of this study. First, the demographics of the undergraduate sample may limit the generalizability of these findings to older age groups. Indeed, all the participants in this study were between the ages of 18 – 25 (Generation Z). Previous work has shown that individuals from Generation Z are more susceptible to the effects of social media compared to older generations (Turner, 2015). As such, the latter may not be as sensitive to manipulations of online status. Second, although it has been argued that an individual's Instagram follower to following ratio can be used as a status manipulation, there could be other explanations for the effects we observed. Indeed, it could simply be the case that logging into Instagram may be more self-affirmative for Instagram leaders (who might use the platform more actively) compared to Instagram followers (who might use the platform more passively). However, future work is needed to address this question.

7.2.5 Chapter 6

Since Chapters 4 and 5 have suggested that online status modulate motor resonance during action observation using physiological and behavioural methods, this chapter examines whether this effect can be observed beyond traditional lab tasks. Indeed, this study sought to test whether online status modulates mimicry behaviour during an online interaction via ZOOM. Importantly, we found that high online status participants (relative to the confederate) exhibited significantly less mimicry behaviour compared to their low online status counterparts. This finding suggests that behavioural mimicry 1) does occur between two people during an online interaction, and 2) it can be modulated by online status. Naturally, this work also raises new questions about the effects of online status on a host of other social cognitive processes.

There are two major limitations of this study. First, factors such as ethnicity and sex of the confederate were not considered in this study. Since researchers have found a link between behavioural mimicry and ingroup bias (Bourgeois & Hess, 2008), these factors could have contributed to differences in mimicry behaviour exhibited by participants during the online interaction. As such, future work is needed to address this question. Second, it is still unclear whether the differences in mimicry behaviour exhibited by participants was due to the relative difference in Instagram followers between participants and the confederate or whether the absolute number of Instagram followers the confederate displayed during the interaction (followers = 3000 vs. followers = 100) played an overarching role. Future empirical work is required to further elucidate on this effect.

7.3 Summary of Overall Results

In summary, this dissertation has shown that socioeconomic status, social power, and online status modulate motor resonance during action observation in similar fashion. The findings presented not only corroborate and extend previous physiological work in the field (Hogeveen et al., 2014; Varnum et al., 2016), they also suggest that online status and offline status may have concordant downstream effects on a host of other social cognitive processes. Importantly, the behavioural effects observed were not only limited to an undergraduate sample, but they could also be extended to adults over the age of 30 from the local community. Furthermore, the findings presented in this dissertation also suggest that some of these downstream behavioural effects can be observed beyond traditional laboratory-controlled conditions.

7.4 Theoretical Contributions and Future Directions

The findings presented in this dissertation provide a basis for our understanding on how online and offline social factors modulate the motor resonance system physiologically and behaviourally. Importantly, they also suggest that real-world status and power have downstream behavioural effects on automatic imitation (a behavioural index of motor resonance) and that these effects can be extended beyond an undergraduate sample.

Unfortunately, we did not find that priming high and low SES individuals to varying levels of social power modulated automatic imitation differently. Instead, we found that both power and status modulate automatic imitation in similar fashion. Specifically, we found that as status and power increase, the interference effect on the AIT decreases. Even though we did not observe an interaction between chronic socioeconomic status and primed social power on automatic imitation, it is still possible that priming high and low SES participants to varying levels of social power may differentially modulate automatic imitation. Indeed, the power priming technique used in this study may have been too weak to elicit behavioural differences. As such, additional empirical studies will be needed to address this issue. Nevertheless, this is the first study to examine this question using a community-based sample (as opposed to an undergraduate sample) and suggest that differences in SES and social power are linked to differences in self–other processing, which could be relevant for broader behavioural tendencies exhibited by individuals at various levels of the social hierarchy.

The findings presented in Chapter 4 suggest that high online status individuals show reduced motor cortical output (as indexed by TMS-induced motor-evoked potentials) during action observation compared to their low online status counterparts. This finding is in line with previous physiological work suggesting that high status/power individuals exhibit reduced motor resonance during action observation, while low status/power exhibit increased motor resonance during action observation (Hogeveen et al., 2014; Varnum et al., 2016). Importantly, this is the first physiological study to explore whether online status modulates motor cortical output during action observation and suggest that online and offline rank may exert concordant effects on interpersonal sensitivity (Hogeveen et al., 2014; Varnum et al., 2016). Future studies are encouraged to incorporate a control muscle during the action observation task, so that the discussion can be extended directly to motor resonance rather than motor cortical output.

Since the findings of Chapters 4 and 5 suggest that online status modulates motor cortical output and automatic imitation, Chapter 6 aimed to extend this work beyond traditional laboratory-controlled conditions, by examining how online status may modulate mimicry behaviour during an online interaction via ZOOM. The findings of this study suggest that high online status participants (relative to their interaction partner) showed reduced mimicry behaviour during the interaction compared to low online status participants. With that said, there remains some debate in the literature on whether findings from automatic imitation studies can be extended to naturalistic mimicry, due to their differences in task and stimuli sets, along with other critical discrepancies (see Genschow et al., 2017; Ramsey, 2018; Cracco & Brass, 2019). As such, although the findings reported in this dissertation contribute meaningfully to the existing literature on this topic, additional empirical work is required to fully address this issue. In addition, future work is also required to determine whether this effect will extend to traditional face-to-face interactions. Indeed, it may be the case that online status may only modulate mimicry behaviour when the interaction is mediated through an online setting. In the future, researchers should also take advantage of a repeated-measures study design, where each participant interacts with a high online status confederate and a low online status confederate (during separate ZOOM sessions) throughout the experiment. This design would allow for a clearer interpretation of the findings. Crucially, a similar experimental design could also be used to examine how a confederate's background (ethnicity, sex, etc.) might modulate mimicry behaviour exhibited by participants during an online interaction.

Importantly, the findings presented in this dissertation are the first to suggest that online status and offline status may have concordant downstream effects on a host of other social cognitive processes. However, since these investigations were exploratory in nature, future empirical work is required to validate the potential concordance between aspects of one's *online self* and their *offline self.* As research on this topic progresses, it will also become important to examine the implications of this connection on other psychological outcomes. For example, it has been suggested that active social media users are at a higher risk for anxiety due to a fear of missing out on important social interactions online or being unpopular on the platform (Dhir et al., 2018; Cataldo et al., 2021). As such, even though social media provides users with rewarding experiences, significant concern about one's *online* self-image and presence may have negative downstream effects on their mental health. Future researchers are encouraged to further explore the influence of these online experiences on real-world outcomes.

7.5 Automatic Imitation

Chapters 2, 3 and 5 present work examining how online and offline social hierarchies modulate the motor resonance system behaviourally using the automatic imitation task. However, one of the main issues that has been consistently highlighted in these chapters is whether differences observed between groups are due to differences in attentional processing or inhibition during response-conflict.

The behavioural findings presented in this dissertation suggest that the differences in the interference effect between low status/power and high status/power groups may have stemmed from differences in attentional processing of the social stimuli used in the AIT (i.e., on-screen hand). This assertion is based on previous work showing power and status related differences in attention (Guinote, 2007; Kraus et al., 2012). Indeed, it has been shown that low power individuals are generally more sensitive to social stimuli compared to high power individuals (Guinote, 2007). This finding is also in line with other work suggesting that since low SES individuals rely significantly on others due to a lack of resources in their daily life, they may naturally be more sensitive to "other-oriented" stimuli compared to their high SES counterparts (Kraus et al., 2012). As such, these differences in attentional processing may have led to the increased interference effect observed in low SES/power individuals compared to their high SES/power counterparts during the AIT.

Even though differences in attentional processing may have led to the differences observed between groups on the AIT, there are other possible explanations that must be addressed. Indeed, it could be that high SES/power participants were simply better at inhibiting task-irrelevant actions during the AIT (i.e., imitating the on-screen hand) compared to their low SES/power counterparts. Of course, a third possibility is that differences in both attentional processing and inhibition during response-conflict may have contributed to the observed differences between these groups. Future research will be required to address this question.

One potential study that could be conducted to disentangle between these possibilities would involve the combination of the AIT and eye tracking software. Since participants are required to make responses to numerical cues, while an on-screen hand is making congruent or incongruent actions, eye tracking data could establish whether there are any group differences in attention. Future work of this kind will allow us to better understand if the differences between groups on the automatic imitation task may have stemmed from differences in attentional processing or inhibition during response-conflict.

7.6 Self-Other Distinction

There is now clear consensus that action observation leads to the activation of an internal motor representation that can be revealed through automatic imitation or motor-cortical activity (Blakemore & Frith, 2005; Heyes, 2010). However, if this is truly the case, then why don't humans constantly imitate their peers? (Jeannerod, 1999; Blakemore & Frith, 2005; Heyes, 2010). One potential explanation put forth by researchers is that individuals can distinguish between their own intentions and these externally triggered motor representations via self-other distinction (Brass et al., 2008). Indeed, by enhancing an individual's *self* over the *other*, they may be less susceptible to imitation.

Recent physiological studies have shown that activity in the temporoparietal junction (TPJ), comprised of the inferior parietal lobe (IPL), lateral occipital cortex (LOC), and posterior superior temporal sulcus (pSTS), plays an important role in this process (Uddin et al., 2007; Heinisch et al., 2012; Donaldson et al., 2015; Patel et al., 2015). One of the supporting arguments for the specialized role of the TPJ comes from studies examining the control of imitative behaviour (Sowden & Catmur, 2015). For example, during the AIT, there is an increase in activation in the TPJ and anterior medial prefrontal cortex (aMPFC) during the incongruent condition (Brass et al., 2000; Saxe & Powell, 2006). Similarly, it was found that when participants viewed actions that were different to the actions they were executing (incongruent trials), they showed a significantly greater activation in the pSTS (BOLD response via Magnetic Resonance Imaging) compared to when they viewed their own hand (congruent trials) (Kontaris et al., 2009).

Importantly, these findings have inspired other researchers to examine how behavioural manipulations of self-other control may translate to performance on self-other control tasks such as the AIT. For example, in a study by Santisteban and colleagues (2012), it was found that participants who were trained to counter-imitate the on-screen hand during the AIT exhibited reduced reaction time (RT) interference effect compared to participants that were trained to imitate the hand. From these findings, it can be argued that training participants to counter-imitate enhanced their self-related processing compared to their other-related processing, and this enhancement led to better performance on the task. Conversely, training participants to imitate the stimuli may have led to the diminution of the *self* compared to the *other* leading to poor performance on the task. Of course, it is also possible that counter-imitation training simply enhanced the participants ability to follow through with task instructions, while imitation training led to a reduction in one's ability to follow the task instructions. Future work is needed to address this issue.

7.7 Conclusion

This dissertation investigated the downstream behavioural and physiological effects of online and offline social hierarchies on the motor resonance system. The primary findings are that high status and high power adults from the local community showed reduced interference effect during the AIT (a behavioural index of motor resonance) compared to their low status and low power counterparts. Similarly, when examining the effects of online social hierarchy, it was found that Instagram followers exhibited increased interference effect during the AIT, as well as increased motor cortical output (indexed by TMS-induced motor-evoked potentials) during action observation, compared to Instagram leaders. These results were also extended to behavioural mimicry, where it was shown that Instagram leaders exhibited reduced mimicry behaviour during an online interaction compared to Instagram followers. I also summarized the important contributions and limitations of each chapter, discussed issues concerning automatic imitation and self-other distinction, and recommended future avenues of research. All in all, this dissertation furthers our understanding on how online and offline social hierarchies modulate the motor resonance system using behavioural and physiological methods. Based on the findings of this dissertation, future researchers are encouraged to further explore how self-other distinction and the attention/inhibition accounts relate to the group differences observed during these behavioural and physiological tasks.

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