BEHAVIOURAL MIMICRY IN SOCIAL INTERACTIONS

AN ANALYSIS OF THE EFFECTS OF BEHAVIOURAL MIMICRY IN SOCIAL INTERACTIONS ON AFFILIATIVE PERCPETIONS OF THE INTERACTION PARTNER

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A Thesis Submitted to the School of Graduate Studies in Partial Fulfilment of the Requirements for the Degree of Master of Science

McMaster University MASTER OF SCIENCE (2018) Hamilton, Ontario
(Department of Psychology, Neuroscience and Behaviour)

TITLE: An analysis of the effects of behavioural mimicry in social interactions on affiliative perceptions of the interaction partner

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PAGES: x, 58

Lay Abstract

This thesis describes empirical research that explores the nature of behavioural mimicry and the impact it has on how people perceive one another. Behavioural mimicry refers to the natural tendency for people to copy one another's behaviours and mannerisms in an interaction. This tendency builds rapport and likeability between the interacting pair. Across three experiments, we expand on previous behavioural mimicry literature. By using novel mimicry manipulations, we demonstrate that behavioural mimicry detection (experiment one) and recognition (experiments two and three) systems are more complex than previously believed.

Abstract

Behavioural mimicry refers to an unconscious and automatic tendency for people to copy each other's actions and mannerisms, while engaging in an interaction. Behavioural mimicry in dyadic interactions leads to an increase in liking, rapport and prosocial behaviour. Given that behavioural mimicry carries a social benefit within the dyad, in the first experiment, we wanted to explore the social consequence of behavioural mimicry in a larger social environment by introducing a third person. The third person was in the background of an interacting dyad (consisting of the participant and a neutral in demeanour confederate) and either (1) mimicked the participant, (2) anti-mimicked the participant, or (3) kept a neutral position throughout the interaction. The results indicated that when one of the interacting partners is anti-mimicked, they report liking their non-mimicking interaction partner more than in either of the other two conditions. In experiment two, we set out to determine whether motor similarity of movement or temporal contingency of movement led to the affiliative judgements often reported in the mimicry literature. We had a research assistant either anatomically mimic (same effector), specularly mimic (different effector) or anti-mimic the participant during a task at either a short or long time delay, and collected participant's likeability judgements of the research assistant. We discovered that anatomical mimicry leads to higher affiliative judgement at short time delay compared to long time delay, that specular mimicry leads to a higher affiliative judgement at long time delay compared to short time delay, and that anti-mimicry leads to the same affiliative judgement regardless of time delay. In experiment three, we wanted to explore the neurocognitive significance of behavioural mimicry. A previous study demonstrated that anodal transcranial direct current stimulation (tDCS) to the inferior frontal cortex (IFC) increased mimicry in a subsequent interaction. We wanted to replicate this finding with one change: we

used a computer task rather than a naturalistic interaction. Following anodal tDCS to the IFC, control site or sham stimulation, the participants watched a video of a female model that touched her face every few seconds. We wanted to determine whether the participant would touch their face more often following the IFC stimulation compared to the other two conditions. Our results were not similar to the previous finding: participants touched their face at similar rates regardless of the stimulation site. Nonetheless, in this thesis, we report a novel social manipulation of behavioural mimicry (mimicry emanating from outside the interacting dyad) that impacts the affiliative feelings within the interacting dyad. We also report a novel form of a mimicking behaviour, that goes beyond the traditional definition, to impact the perception of the interaction partner at a longer time delay.

Acknowledgements

I would like to first and foremost thank Dr. Sukhvinder Obhi for all of his guidance and inspiration throughout this journey. I would also like to thank committee members Dr. Jennifer Ostovich and Dr. Scott Watter for their advice and evaluation of my research protocols. A special thanks to the members of the Social Brain, Body and Action Lab for always being there to discuss new research ideas and for making my Master's degree so enjoyable. Lastly, I would like to thank my family and friends for supporting me throughout my education and encouraging me to pursue my goals and aspirations.

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General Introduction

Human interactions occur daily; whether in a professional or social context and with friends and strangers alike. During these everyday interactions, there is a strong tendency for people to move and act similarly to one another; in other words, people tend to mimic each other's behaviours. This tendency is an automatic and unconscious process that occurs naturally, and for this reason it has been termed the *Chameleon Effect* (Chartrand and Bargh, 1999). Typically, behavioural mimicry is said to occur when an imitative behaviour happens within 3-5 seconds of the original movement. Behavioural mimicry leads to many individual and social benefits, which are described in detail below. The present thesis contributes to empirical research on mimicry. Specifically, across three experiments, I assessed whether mimicry from an individual outside the dyad exerts any positive effects on the person being mimicked, and the extent to which motor similarity and temporal contingency contribute to the prosocial effects of behavioural mimicry.

Behavioural Mimicry & Social Psychology

Facilitators of Behavioural Mimicry

Early research on behavioural mimicry focused on mimicry in pairs with pre-existing relationships, for example councillors and patients (Scheflen, 1964) or students and teachers (La France, 1982). This correlational research demonstrated that postural similarity in the pairs indicated positive rapport and similarity in opinions. However behavioural mimicry wasn't explored in a controlled lab setting until the now classic study by Chartrand and Bargh (1999). In their study, Chartrand and Bargh had a confederate perform targeted movements (i.e. face touches or foot movements) and they discovered that participants in the target movement group

performed significantly more target movements than participants in a neutral group. In a manipulation of the first study, they had a confederate mimic the movements and postures of the participant and discovered that the mimicking behaviours led to participants reporting higher likeability of the confederate and higher overall smoothness of the interaction than when no mimicry was performed during the experiment.

Since these initial findings, research on behavioural mimicry accelerated, leading to the discovery of a number of behavioural manipulations that can facilitate the amount of behavioural mimicry conducted by an interacting pair. These facilitators of mimicry are described below.

Pre-existing Rapport/Similarity

Behavioural mimicry increases when the interaction partners have pre-existing rapport. For example, friends tend to mimic each other more than they mimic strangers (McIntosh, 2006) and in-group members tend to exhibit more mimicry toward one another than toward an outgroup member (Bourgeois & Hess, 2008). Bourgeois and Hess had participants view clips of politicians with whom the participants expressed similar (in-group) or non-similar (out-group) beliefs with and recorded their facial mimicry of the politician's expressions. They discovered that participants mimicked both politicians' happy expressions, regardless whether they agreed with the polices of the politician, but mimicked the negative emotions (anger) only of the in-group politician. Recently, Van Swol and Drury-Grogan (2017), demonstrated that people tend to mimic the behaviours of the individual that they have similar opinions to rather than the behaviours of the individual with dissimilar opinions. Interestingly, even incidental similarities such as sharing the same name, birthday or major leads to an increase in observed mimicry (Gueguen, Martin, Meineri, & Simon, 2013; Gueguen & Martin, 2009). So, being friends or

having something in common with others makes you mimic them more. Interestingly, there are cases when people do mimic strangers, for example, when we want to become their friend.

Goal to Affiliate

Behavioural mimicry increases when there is a goal to affiliate with another, as demonstrated by Latkin and Chartrand (2003). In their study, participants were either primed with an affiliation goal or given no affiliative instructions. They were then asked to watch a "live" video of a girl performing administrative tasks while touching her face once in a while (the video was actually a pre-recording). The participants were told that they would later need to recall the tasks that the girl performed. Those participants that were given an affiliative goal at the start of the study, mimicked the face touches of the girl in the video more, than those participants that were given no affiliative goal instructions. The mere desire to be friends with the girl in the video led participants to display more mimicking behaviours.

Personality Traits

Certain personality traits facilitate the amount of behavioural mimicry performed by individuals. Chartrand and Bargh (1999) demonstrated that individuals high in perspective taking mimic their interaction partner more than those low in perspective taking; referring to those high in perspective taking as high in dispositional empathy – since they are able to put themselves in another's shoes. This initial finding relates to personal self-construal views. Self-construals refer to the different ways of defining one's self in terms of one's relationships with others: a person with an *independent* self-construal views themselves as being independent of others, and a person with *interdependent* self-construal views themselves in terms of the relationships they

hold with others. Not surprisingly, people high in interdependence exhibit more mimicry than those with independent self-construal, whether the self-construal is word-primed or culturally innate (Van Baaren, Maddux, Chartrand, de Bouter & van Knippenberg, 2003). Moreover, a recent study by Duffy & Chartrand (2015) demonstrated that *extraverts* exhibit more mimicking behaviours in interactions with others, but only when given a goal to affiliate. This increased mimicking behaviour was absent in a condition where no affiliative instructions were given, suggesting that when extraverts want to make friends they employ the tactic of behavioural mimicry to seem more favorable to their interaction partner.

Emotional State

As with personality traits, current mood can influence the amount of behavioural mimicry exhibited by participants. Using media clips, van Barren et al. (2006) induced either a positive or a negative mood in participants. Participants who were left in a positive mood later mimicked the confederate's pen-playing more than did participants who were left in a negative mood (Van Baaren, Fockenberg, Holland, Janssen, & van Knippenberg, 2006). A later study by Likowski et al. (2011), found that happy people mimic the facial expressions of happy, sad, neutral and angry individuals more than do unhappy people. Interestingly, unlike other negative emotions, the negative emotion of *guilt* increases (rather than decreases) the amount of mimicry people express (Martin, Gueguen and Fischer-Lokou, 2010). As part of a guilt-inducing study, in one condition, participants were led to believe that they were responsible for slowing down a confederate by bumping into them and making them drop a bunch of papers to the ground; in another condition the confederate took the blame for the incident. When the participants were later asked to watch a video of another confederate touching/ rubbing her face, those in the guilt condition mimicked

the target behaviours more than those in no-guilt condition, and the amount of mimicry conducted was directly related to the experienced level of guilt.

Social Consequences of Behavioural Mimicry

As discussed there are lots of facilitators of behavioural mimicry, but what happens once mimicry occurs? Are there social benefits of experiencing behavioural mimicry? As previously mentioned, Chartrand and Bargh (1999) demonstrated that mimicry seems to increase *likeability* and facilitates the interaction in a pair. However, there are other interesting social consequences to the mimicker and the mimickee that are considered next.

Persuasiveness

How persuasive someone is can be influenced by behavioural mimicry. Van Swol (2003) conducted a study in which a participant was in a room with two confederates: one confederate mimicked the participants' behaviours and one did not. During the experiment the two confederates and the participant all disagreed on a certain topic. Mimicked participants reported that they found the mimicking confederate more knowledgeable, persuasive and confident than the non-mimicking confederate, although ultimately their opinions on the topic were not swayed. However, another study by Bailenson and Ye (2005) found that mimicry does influence participants' attitudes. They used computer avatars that delivered a certain message to the participants and these avatars either mimicked the head movements of the participant or played-back head movements from another participant. Participants rated the *mimicking* avatars as being more persuasive than the *non-mimicking* avatars, and they tended to agree with the message that the *mimicking* avatar delivered.

In another persuasion study, when participants were mimicked by the experimenter while describing a fictional drink to them, the participants were more likely to report that they enjoyed the drink and that they were likely to purchase it in the future than when they were not mimicked (Tanner, Ferraro, Chartrand, Bettman, & Van Baaren, 2008). Interestingly, in a second study by Tanner et al. (2008) when participants simply observed a confederate eating a snack while doing something else and had the same snack (among other snacks) in front of them, they were more likely to eat the same snack as the confederate and to rate it favourably.

Empathy/ Emotion Perception

In the early work on behavioural mimicry, a study examining relationships between teenagers and their counselors found that when being mimicked by their counsellor, the teenagers found them to be more empathetic (Maurer & Tindall, 1983). However, it seems that perceived empathy is mediated by how genuine the person is perceived to be. In one study, participants were instructed to copy facial emotions of a reality television star while they were watching a TV show clip. When emotions of the reality star were judged to be real, participants in the mimicry condition reported more perspective taking, however when emotions were perceived as fake, mimicry had no effect on perspective taking (Stel & Vonk, 2009).

Interestingly, behavioural mimicry also leads to increased accuracy in identifying emotions. When participants were asked to avoid making any facial expressions while viewing a set of photographs expressing emotions, they were slower to identify the emotions compared to a group of individuals that were asked not to move their shoulders (Stel & van Knippenberg, 2008; Oberman, Winkielman, & Ramachandran, 2007). Similarly, when participants were administered

Botox, thereby physically impeding their ability to mimic facial expressions, they were less accurate at identifying the emotions others were experiencing (Neal & Chartrand, 2011).

Prosocial Behaviour

Apart from emotion recognition, behavioural mimicry also increases prosocial behaviour, sometimes referred to as helping behaviour, which can be expressed in a number of ways. For example, in a study by van Baaren et al. (2003), when a waiter verbally repeated (mimicked) the order to the customer, the customers tended to leave a larger tip at the end of the meal, compared to a waiter that did not mimic back the order. In another study, participants were more likely to help the experimenter, who had dropped a box of pens (by picking-up the pens), when the experimenter had previously mimicked them compared to when no mimicry was performed (van Baaren et al., 2004).

Additionally, in a previously described study by Tanner et al. (2008), if the confederate that was mimicking the participant while describing a new drink to them had financially invested in that product, participants were more likely to report that they liked it and that they were likely to buy it in the future than when the confederate did not mimic the participant during the product description. The authors interpreted these results as prosocial behaviour: participants saying that they liked the drink and were likely to buy it in the future is helping someone who has invested in that product.

Interdependence

Interdependence was previously described as a facilitator of behavioural mimicry, but it can also be a social *consequence* of mimicry. When participants were mimicked by a

confederate, they expressed more interdependent self-descriptors and reported feeling closer to others than those participants who were not mimicked by a confederate. In the same study, students who were mimicked chose to sit closer to a visibly occupied chair than those students who were not mimicked, presumably demonstrating induced interdependent self-construal (Ashton James et al., 2007).

Increased Trust/ Perception of Honesty

Perhaps as a result of increased feelings of interpersonal closeness following mimicry, there is evidence of an increase in trust following mimicry. When asked increasingly personal questions by either a mimicking or non-mimicking confederate, mimicked participants were more likely to disclose personal information to strangers than were those who were not mimicked (Gueguen, Martin, Meineri, and Simon, 2013). Similarly, when asked about their ecological actions/ behaviours, mimicked individuals were more likely to answer honestly than were non-mimicked individuals (Gueguen, 2013).

As can be seen, there is a large literature devoted to the study of behavioural mimicry in social interactions, and a correspondingly large literature on the effects of mimicry on affiliative feelings and prosocial behaviours. Social psychological studies have formed the majority of the corpus of research on mimicry, but there is increasing work investigating the neural basis of mimicry. In the next section, I consider studies on mimicry that have focused on the neurocognitive levels of analysis.

Behavioural Mimicry & Neuroscience

Since the discovery of behavioural mimicry, neuropsychologists have been interested in understanding the mechanisms underlying it. The following section provides a brief summary of research that relates behavioural mimicry to its neurocognitive bases.

Early hypothesis

In the 1990s, *mirror neurons* were discovered in the premotor cortex of macaque monkeys, termed area F5. Crucially, the premotor neurons fired not only when the monkeys were performing an action, but also when they were passively observing an action, hence the term, 'mirror neurons' (di Pellegrino et al., 1992). It was hypothesized that these neurons existed to understand the intention of the motor acts executed by others, which would have been ecologically useful for survival in the past.

This initial finding in primates lead to research trying to pinpoint whether a similar mirror system existed in humans. A transcranial magnetic stimulation (TMS) study by Fadiga et al. (1995) determined that stimulation to the left primary motor cortex elicited motor activation in participants' right hand, when passively observing an experimenter grasp an object. TMS is a non-invasive neuro-stimulation apparatus that when used over the motor cortex, evokes a muscle response in the corresponding part of the body. When participants are observing another individual performing a grasping action while TMS is being delivered to their motor cortex, the muscle response in their own muscle (i.e., involved with grasping) is activated to a greater degree than when motor cortex is stimulated while not observing a grasping action. Some have speculated that this activation of the motor system during action observation (termed motor resonance) reflects the activity of a human mirror system (Iacoboni, 2005; Iacoboni, 2009).

However, it is difficult to ascertain whether modulation of human motor system activity during action observation reflects activation of "mirror neurons". Despite this, the finding that motor activity is modulated during action observation is robust, and some have argued that such activation could underlie the social phenomenon of mimicry (Obhi, 2016).

Current hypothesis

As mentioned above, "motor resonance" refers to motor activity during action observation that occurs in the absence of action execution. There are several methods for studying motor resonance including the use of TMS in conjunction with action observation, and the behavioural automatic imitation task (AIT). These imitation tasks are similar to behavioural mimicry in that imitation is not instructed but rather occurs naturally through observation (Brass, Bekkering, & Printz, 2001). Additionally, further supporting the link between behavioural mimicry and motor resonance, a study by Hogeveen and Obhi (2012) demonstrated that social interactions with others prime the motor system. Those participants who had engaged in a mimicking social interaction with an experimenter prior to action observation task demonstrated more motor resonance, as assessed via TMS evoked muscle responses, compared to those that did not experience mimicry in a social interaction.

It is clear that mimicry is a low cost strategy that leads to harmonious interactions with other individuals (Lakin, Jefferis, Cheng & Chartrand, 2003). Mimicry seems to act like a "social glue" that keeps interactions pleasant and effortless for the people involved (Latkin, Jefferis, Cheng, & Chartrand, 2003). There is some suggestion that motor resonance may contribute to mimicry, but the underlying mechanisms of mimicry remain to be fully understood. This thesis

comprises research that attempts to further understand the social and neurocognitive nature of behavioural mimicry, and in so doing seeks to add valuable information to an already rich literature.

Experiment One

Introduction

The mimicry studies previously outlined in this thesis provide empirical support that behavioural mimicry within a dyad increases liking, rapport and prosocial behaviour within, and in some cases beyond, the dyad. However, social interactions often occur in environments with multiple agents, (m)any of whom may be sources of mimicry. In experiment one, we were interested in investigating how third person mimicry might affect the affiliative perceptions within the dyad. We positioned a third-person in the vicinity of an interacting dyad (consisting of a participant and a non-mimicking confederate) such that they were visible to the participant. The third-person either mimicked the participant, anti-mimicked the participant, or remained neutral throughout the interaction. The true participant was then asked to fill out a questionnaire designed to assess the participants' perceptions of the confederate. We also assessed how prosocial the participant was after the interaction, by means of a pen dropping task in which pens were dropped in the vicinity of the participant, and the number of pens picked up by the participant was taken as a measure of prosociality. We hypothesized that third person mimicry would impact participants' perception of their interaction partner, such that a "carry-over effect" would take place, in which the interaction partner would be perceived more favourably because they are in the vicinity of a mimicking third individual. We also believed that the participants would act more prosocially following third-person mimicry, as a study by Van Baaren, Holland,

Kawakami & van Knippenberg (2004) suggests that post-mimicry prosociality is not specific to the mimicking source.

Methods

Participants

148 students were recruited from an introductory psychology participant pool at McMaster University (120 female, 28 male).[1] The study was approved by the local research ethics board and each participant provided informed consent prior to the start of the experiment. The study was conducted over *two* academic years, and participants received a partial course credit for taking part in the study.

Materials

Room Set Up: The testing room contained three chairs; one chair was designated for the third person (a role always played by the person posing as the experimenter), one for the confederate and the last chair was left for the participant. The participant was always led to believe that the confederate was another participant who had signed up for the study. The third person and the confederate always sat in the same chairs with the third person sitting approximately 2 feet behind (and slightly to the right of) the confederate; the participant sat 4.5 feet directly in front of the confederate. The chairs were strategically placed so that both the third person and the confederate were in the visual field of the participant (**Figure 1**). To the participant, it

[1] Note that, due to an oversight, we did not collect age information from the participants so are unable to report the age data for the sample. As mentioned in the text, participants were recruited from an introductory psychology class, and were thus in their first year of university study.

Fig. 1. **Participant's Field of View**. The visual field of the participant during the photograph description task. The participant faced both the confederate and the experimenter. The confederate was only facing the participant. Left picture is an example of when confederate was listening to the photo description given by the participant, and right picture is an example of when confederate was describing their photo to the participant. In all conditions, the experimenter sat behind the confederate, but nonetheless in the visual field of the participant and either mimicked or anti-mimicked the participant. In a control condition, they sat in a neutral position.

appeared that the third person was simply sitting in the background waiting for the pair to finish the experimental task. The entire experiment was covertly video-recorded via a video camera hidden within a small white box and placed on top of a closet door behind the participant. The camera placement allowed for movement recording of all three individuals throughout the duration of the experiment.

Photograph Description Task: In line with past mimicry research, the participant and the confederate engaged in a photograph description task (Lakin & Chartrand, 2003). Sixteen photographs from the *National Geographic* magazine were used for the purpose of this experiment (for a similar approach see Hogeveen et al., 2015). The confederate always had the same 8 of the 16 photographs, and had memorized a script associated with each of the photographs. To make the interaction seem as natural as possible, the confederate was pre-trained to incorporate appropriate pauses and speech disfluencies, such as "umms" and "hmms" throughout the interaction.

Experimental Procedure

The experimenter greeted the participant at a designated waiting area and took them down a hallway to the testing room. While walking to the testing room, the experimenter explained that a second participant (really a confederate) had already arrived for the experiment and was waiting in the room. The confederate always sat on a waiting area couch at one end of the testing room. Upon arrival at the room, the experimenter ushered the confederate and the genuine participant towards two pre-located chairs in the room and asked them to take a seat in one of the two chairs. The confederate always proceeded to sit in her designated seat first,

leaving the participant to sit in the chair across from the confederate. The experimenter then explained the (bogus) purpose of the *photograph description task*: the purpose being to investigate the ease with which individuals are able to describe the given photographs to one another. They were then asked to read and sign a consent form that further elaborated on this cover story.

Following informed consent, the experimenter provided the confederate and participant with the photographs. These photographs were placed facedown and the to-be-interacting pair were asked not to look at the photographs until it was their turn to describe the details of a picture. The experimenter then asked the confederate to start describing her first photograph. The confederate always described their first picture first so that the participant would have a guideline as to the amount of detail to include in their description. Following the confederate's description, the experimenter asked the participant to describe their first picture. Having provided this instruction, the experimenter proceeded to sit down in her designated seat and thus became the incidental "third person" (behind the confederate). For the rest of the interaction the confederate and the genuine participant took turns describing the photographs. Throughout the photograph description task the third person subtly mimicked the participant (copying behaviours within approximately 3-5 seconds), anti-mimicked the participant (made movements that were unrelated to the participant's natural movements within approximately 3-5 seconds), or remained neutral (sat with hands on knees). The confederate remained in a neutral demeanour during the entirety of the photograph description task in all 3 conditions. Specifically, when describing a picture, the confederate held the picture with both hands but, when the participant was describing the picture, the confederate kept both hands on her lap on top of the pictures.

Importantly, the confederate was always blind to the experimental condition, ensuring that the confederate's behaviour remained the same throughout the experiment.

Experimental testing took place over two academic years and throughout this time two female students took on the confederate and the third person (experimenter) roles. The specific person in each role was counterbalanced across participants so that each person acted as third person (experimenter) or confederate for an equal number of participants. Since the study was conducted over more than one school year, one of the female students was replaced part way through the study, but her role was again counterbalanced with the other student. This counterbalancing procedure was used to eliminate any bias one individual might induce in the participant in a particular role (experimenter or confederate). Following the photograph description task, the experimenter asked the participant and the confederate to fill out a questionnaire consisting of seven pages and three measures. To maintain the cover story, the confederate was asked to leave the room with the experimenter to be taken to another location where she would fill out the questionnaire. Thus, the genuine participant was always left alone in the room to complete their questionnaire measures.

Measures

Affiliative measures. Our main interest in the current study was whether the participant's liking for the confederate would be affected by the presence or absence of mimicry performed by a third person. Questions similar to those used in past research were used in this study (Lakin & Chartrand, 2003; Hogeveen, Chartrand, & Obhi, 2014). Specifically, participants completed a brief questionnaire in which they answered three questions: (1) how likeable was the other participant during the photograph description task, (2) how smoothly would you say your

interaction with the other participant went during the photograph description task, and (3) would you like to spend more time with the other participant. Participants answered these questions using a 5-point *Likert* scale. Although not central to our hypotheses, for completeness, in a separate set of questions, we asked participants about how likeable they found the experimenter to be.

Prosociality. Participant prosociality was assessed in two ways, one being a self-report measure of trait prosociality, and the other being an actual assessment of helping behaviour after the mimicry manipulation. For the self-report measure, participants answered 16 *Likert* scale questions (Caprara, Steca, Zelli, & Capanna, 2005). The questions are designed to assess helpfulness, sharing, consoling, supportiveness, and cooperativeness traits of the individual. The behavioural measure of prosociality was assessed using the "pen-drop" approach previously used by Van Baaren, et al. (2004). Because post mimicry prosociality has been found to generalize beyond the interaction partners in the dyad (Van Baaren, et al., 2004; Stel, Van Baaren, & Vonk, 2008; Ashton–James, Van Baaren, Chartrand, Decety, & Karremans, 2007), we assessed helping behaviour in situations both when the experimenter required help and in situations when the confederate required help. Specifically, in the first year of testing, the experimenter "accidently" dropped pens out of a box in front of the participant. In the continuation of testing in year 2, we had the confederate drop pens in front of the participant. In both cases, if the participant failed to pick up the pens in a 10 second window, the individual that dropped the pens would proceed to pick them up.

Inclusion of Others in Self (IOS). Venn-like diagrams of two circles (one to represent self and one to represent the person you have the closest relationship with) were used to assess how interconnected people feel with others in general (Aron, Aron & Smollan, 1992). This was included as a measure of participants' perceptions of their chronic social interconnectedness.

Debriefing

After completing all measures, participants underwent a thorough funnelled debriefing procedure with the experimenter. They were probed for (a) general suspicions, (b) what they thought the purpose of the study was, (c) whether they noticed anything specific about the photograph description task and whether, during the photograph description task, they noticed any specific mannerism conducted by (d) the participant and (e) the experimenter. Following this funnelled debriefing procedure, the participants were fully debriefed about the true purpose of the study.

None of the participants correctly guessed the true purpose of the experiment, and neither did they report being aware of the mimicry or anti-mimicry conducted by the experimenter.

Results

In the first year of testing, four participants suspected that the other participant was a confederate. The data from these participants was removed from further analyses. Additionally, the data from eleven participants was removed, because upon video review it became apparent that the experimenter accidentally anti-mimicked the participant in the mimicry condition. Thus, 52 participants from year 1 of testing contributed to the overall data set for statistical analysis. In

the second year of testing, the video camera malfunctioned and failed to record data for 3 participants. In addition, 4 participants were removed after reviewing the videoed interaction, as the experimenter did not perform the mimicry/anti-mimicry manipulation correctly. This left a total of 74 participants from year two of testing. Thus, over the span of two years data from 126 participants was collected and then subjected to inferential statistical analysis (50 mimicry, 50 anti-mimicry, 26 control).

Likeability of the Confederate

A between-subjects analysis of variance (ANOVA) with the factor condition (mimicry, anti-mimicry, control) was conducted on mean scores to the question: "How likeable was the other participant during the photograph description task?" The effect of condition was found to be significant ($F_{(2, 123)} = 5.2$, p= .007, $\eta^2_p = .08$). This effect was further explored via independent samples t-test which showed that likeability ratings for the confederate were significantly higher in the *anti-mimicry* condition (M=4.26, SD= 0.69) compared to the *mimicry* condition (M= 3.82, SD= 0.80; t(98)= 2.94 , p= .003, d=0.59, **Fig. 2**). Additionally, likeability for the confederate was also significantly higher in the *anti-mimicry* condition compared to the *control* condition (M=3.85, SD=0.68; t(74)= 2.49, p= .021, d= 0.60, **Fig.2**). There was no significant difference in likeability between the mimicry and the control conditions (t(74) = 0.14, p= .88, d= 0.04).

Smoothness of Interaction with Confederate

A between-subjects ANOVA with the factor condition (mimicry, anti-mimicry, control) was conducted on the mean scores for the question "How smoothly would you say your

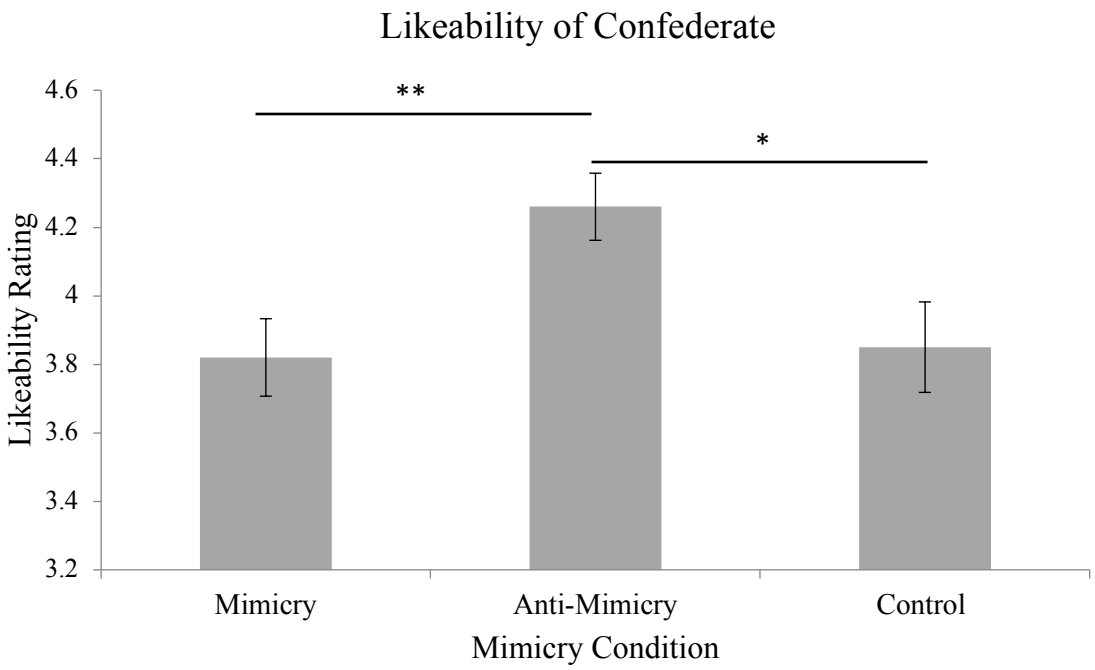

Fig. 2. Likeability Participants rated how much they liked the other participant on a 5-point *Likert* scale. Participants in the anti-mimicry condition liked the confederate significantly more than the participants in either the mimicry condition (** p= .003) or the control condition (* p = .021).

interaction went with the other participant during the photograph description task?" There was no significant effect of condition ($F_{(2,123)} = 0.90$, $p = .41$, $\eta^2_p = .01$).

Desire to Spend More Time with Confederate

A between-subjects ANOVA with the factor condition (mimicry, anti-mimicry, control) was conducted on the mean responses for the question**:** "Would you like to spend more time with the other participant (to get to know him or her better)?" There was no significant effect of condition ($F_{(2, 123)} = 2.02$, $p = .14$, $\eta^2_p = .03$).

Helping behaviour in the pen drop task - Behavioural Measure of Prosociality

In the first year of testing, the experimenter dropped the pens and in year 2 of testing the confederate dropped the pens. There was one other (unintended) critical difference between the two scenarios that prohibited us from analysing combined data from the two years of testing. Specifically, in the first year of testing, the experimenter dropped pens and the participant was the only person present who could potentially help. In the second year of testing, the confederate dropped the pens, but the experimenter remained present and therefore created potential conditions for diffusion of responsibility. Owing to this difference between the scenarios in years 1 and 2, we decided to analyse helping behaviour for the two phases of testing separately by analysing the helping behaviour when the experimenter dropped the pens (year 1) and when the confederate dropped the pens (year 2).

For year 1 of testing, in which the experimenter dropped the pens, an independent samples t-test revealed a significant effect of mimicry condition on the number of pens picked up by the

participant ($t(47) = 2.04$, $p = .047$, $d=0.58$, **Figure 3**). Specifically, participants picked up significantly more pens when they were *mimicked* (M=5.30, SD=2.32) than when they were *anti-mimicked* (M=4.04, SD= 2.03). In year 2 of testing, when it was the confederate who dropped the pens, a between-subjects ANOVA with the factor condition (mimicry, anti-mimicry, neutral) revealed no effect of mimicry condition on the number of pens that participants picked up ($F_{(2,74)} = 0.035$, $p = .96$, $\eta^2_p = .001$).

Self-Report Measure of Prosociality

For each subject, a mean of the 16 prosociality questions was obtained to represent trait prosociality. A between-subjects ANOVA revealed that the self-reported prosociality did not significantly differ between the three mimicry conditions ($F_{(2, 123)} = 1.25$, $p = .29$, $\eta^2_p = .02$).

Inclusion of Other in Self (IOS) Analyses

A between-subjects ANOVA revealed that there was no significant difference between the mimicry, anti-mimicry and neutral conditions for responses on the IOS scale, $F_{(2,123)} = 0.499$, $p = .61$, $\eta^2_p = .008$.

Discussion

When the participant was *anti-mimicked* by the third-person, they reported liking their non-mimicking interaction partner more than in the other two conditions. Third-person-mimicry affected the likeability ratings within a dyad: liking for the interaction partner is inferred by contrasting between the different sources of mimicry in the visual field. Anti-mimicry emanating from a third person in the field of view seems to be compared with mimicry emanating from the

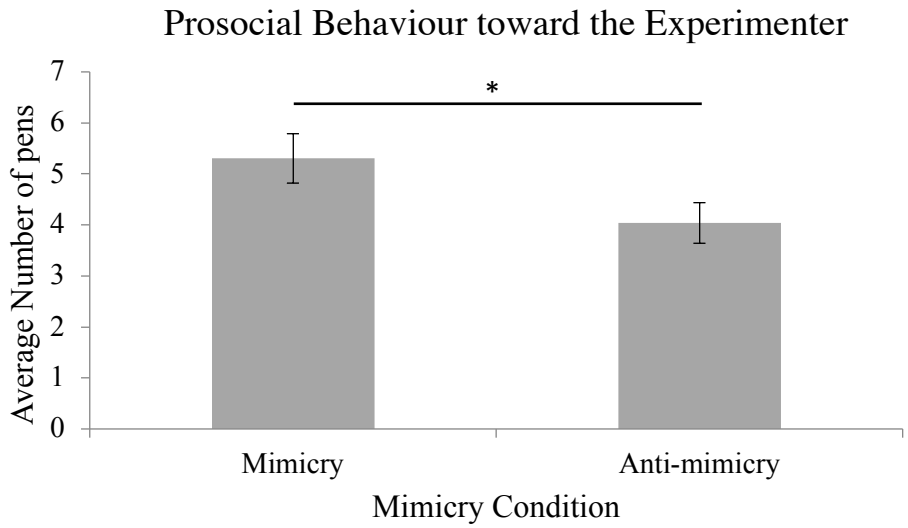

Fig. 3. Behavioural Prosociality Experimenter dropped pens in front of the participant and the participant was given an opportunity to help the experimenter by picking up the pens. Participants in the mimicry condition picked up significantly more pens than the participants in the anti-mimicry condition (*p= .047).

confederate (in this case no mimicry was conducted) to determine how likeable the confederate is. We propose that the systems detecting mimicry are "smart", they do not misattribute negative feelings that arise from anti-mimicry from an outside source to their interaction partner; but instead judge their interaction partner in relation to anti-mimicry emanating from another visible agent. Hence, we suggest that the brain is sensitive to the mimicry emanating from the entire social environment and is capable to keep track of the mimicking source, and not just the mere presence of mimicry.

In general, mimicry must not only be *produced* during an interaction, but it must also be *registered and tracked*. Thus, we propose that mimicry as a phenomenon involves two sets of mechanisms; a *mimicry production mechanism* and a *mimicry detection and tracking mechanism*. There are several information processing steps required to produce mimicry, involving registration of movements of an interaction partner and activation of motor structures in the observer's brain. As mentioned earlier in the thesis, it has been suggested that mimicry production mechanisms may involve a putative mirror system that simulates observed behaviour (Obhi, 2016; Chartrand & Bargh, 1999; James, 1890; Greenwald, 1970; Knuf, Aschersleben, & Prinz, 2001; Iacoboni, 2009; Frith & Frith, 2006).

The current results suggest that the proposed and hypothetical mimicry detection and tracking mechanisms are sensitive not only to mimicry information emanating from the interaction partner, but also from other mimicry information in the visual field. Furthermore, computation of the likeability of the interaction partner (i.e., the confederate in the present study) appears to involve a direct contrast between the mimicry information emanating from the interaction partner and other mimicry information in the visual field. The output of this contrast seems to determine how likeable the interaction partner is.

In addition to the primary likeability results, we also found that being mimicked by the third person was associated with more helping behaviour (measured in the pen drop task) compared to being anti-mimicked by the third person (Van Baaren, et al., 2004). Interestingly though, this helping difference only occurred when it was the third person (i.e., the experimenter) who dropped the pens. It seems unlikely that this difference in helping behaviour was due to differences in trait prosociality between groups, as the prosociality questionnaire revealed no significant difference between the mimicry conditions (see Caprara, et al., 2005). The fact that there was no difference in helping behaviour when the confederate dropped the pens may seem contradictory to some previous research suggesting that prosocial effects of mimicry are general and not linked solely to the source of mimicry (Van Baaren, et al., 2004). One possible explanation for this lack of significant difference in helping behaviour when the confederate dropped the pens could be the presence of the experimenter in proximity to the pen drop when the confederate dropped the pens. Diffusion of responsibility could have occurred, since the experimenter was close enough and wasn't displaying helping behaviour toward the confederate - some participants could have taken that as a social cue and behaved similarly.

Finally, the IOS scale (Aron, Aron & Smollan, 1992) results revealed no significant difference between the three conditions in how interconnected the participants felt with their closest relationship. Given this, the pattern of increased liking that we found cannot be explained by one group generally having a heightened sense of interconnectedness compared to the others.

To summarize, this study demonstrated that people's conceptions of their interaction partners can be shaped by the behaviours of others in the room, who themselves are not involved in the interaction. This seems to happen without awareness and appears to involve a contrast

between the nature of mimicry being displayed by the interaction partner and the nature of mimicry being displayed by the third-person. We consider this study as proof of principle that third-person mimicry can influence social appraisals within a dyad.

Experiment 2:

Introduction

Traditionally, behavioural mimicry has been defined as two people engaging in the same action within 3-5 seconds of one another (Chartrand & Latkin, 2013). However, from this definition it's hard to ascertain whether it's the *motor similarity* of movement or *temporal contingency of movements* that are driving the likeability and prosociality effects being reported in the literature. In fact, we were only aware of one recent study that looked at how temporal delay of an imitative behaviour affects affiliative perceptions (Dignath, Lotze-Hermes, Farmer and Pfister, 2017). Those researchers examined how temporal delays in movement matching between participant hand movement and computer model's hand movement affected the affiliative perception of the model. They discovered that participants preferred models that moved in close proximity to their own movement. However, this study was conducted with a computer task, and to our knowledge there has been no attempt to dissect whether similarity in movement or temporal contingency are responsible for the affiliative perceptions of a partner in naturalistic social interactions.

Additionally, the properties of the *motor* aspects of mimicry reported in the literature are vague. At least two types of mimicry are possible; one could be classed as specular mimicry, in that the mimicker moves in such a way as to create the mirror image of the movement of their interaction partner. The second type of mimicry could be classed as anatomical mimicry, in that

the mimicker moves the same effector in the same way as their interaction partner. Unfortunately, in the mimicry literature, it is never specified whether specular (mirror image; different effector), anatomical (same effector) or a mixture of both mimicry types is performed during any given experiment (LaFrance, 1982; Chartrand & Bargh, 1999; Sanchez-Burks, Bartel & Blount, 2009; Stel, et al., 2010). Although some studies define mimicry as either the number of "target behaviours" made during an interaction, or even the time spent performing the target behaviours during the interaction (Van Baaren, Maddux, Chartrand, De Bouter, & van Knippenberg, 2003; Latkin & Chartrand, 2003; Chartrand and Bargh, 1999), it is never specified whether the target behaviour is analysed in terms of the effector used.

Thus, in experiment two, we were interested in investigating whether motor similarity or temporal contingency are driving the affiliative effects commonly reported in the mimicry literature. We manipulated *motor similarity* by training a research assistant to either perform anatomical mimicry (i.e., use the same effector), specular mimicry (use the opposite effector) or anti-mimicry whilst engaging in a social interaction with a participant. Anti-mimicry has previously been used in research in contrast to mimicry, and simply refers to unspecified and random movements in response to participant's movement (Hogeveen, et al., 2014). We manipulated *temporal contingency* by training the research assistant to move at one of two temporal delays when mimicking the participant. One delay was classed as "short" (3-5 seconds after movement) and the other was classed as "long" (10 seconds after movement). We then collected affiliative judgements about the research assistant from the participants in each of the six experimental conditions. Given the purported role of motor resonance in mimicry, and previous work suggesting that short latency mimicry yields higher affiliative scores, we hypothesized that motor similarity and short temporal latency would lead to higher affiliative

judgements than motor dissimilarity and long temporal latency. We assumed that anatomical mimicry rather than specular mimicry would produce the strongest affiliative judgements, because anatomical mimicry comprises more of an exact match with the participant's movement. In this experiment, our aim was to specify, with greater granularity, the aspects of mimicry that drive its well-known affiliative effects.

Methods

Participants

Ninety-eight students, aged between 17 and 21, were recruited from an introductory psychology research pool at McMaster University. Of the 98 participants, 6 failed to properly fill out the questionnaire, one had a pre-existing relationship with the research assistant (RA), and for one the RA failed to anti-mimic the participants behaviours, leaving 90 (78 female, M_{age}= 18.25) participants for data analysis. The study was approved by the local research ethics board and each participant provided informed consent prior to the start of the experiment. Prior to arrival for the experiment, the participants were assigned to one of six conditions: anatomical mimicry at short time delay (N=15, 12 female, M_{age}=18.27), anatomical mimicry at long time delay (N=15, 14 female, M_{age}=18.47), specular mimicry at short time delay (N=15, 14 female, M_{age}= 18.29), specular mimicry at long time delay (N=15, 13 female, M_{age}=18.20), anti-mimicking at short time delay (N=15, 13 female, M_{age}=18.07), and anti-mimicry at long time delay (N=15, 12 female, M_{age}=18.20).

Materials

Room set-up: The testing room contained two chairs that were facing each other and were approximately 60 cm apart. One chair was designated for the research assistant (RA) and one for the participant; the RA always sat in the same chair, leaving the participant with the other. During the experiment the room was covertly video-recorded using a wall-mounted, two-camera Noldus video recording system. The location of the cameras allowed for video recording from two vantage points of all the movements performed in the room (**Fig. 4**).

Photograph Description Task: In line with past mimicry research, the participant and the confederate engaged in a photograph description task (Lakin & Chartrand, 2003). Sixteen photographs from *National Geographic* magazine were used for the purpose of this experiment (for a similar approach see Hogeveen et al., 2015). The RA always had the same 8 of the 16 photographs, and had memorized a script associated with each of the photographs.

Procedure

The RA who was blind to the hypothesis and the purpose of the study, greeted each participant by the door at a designated waiting area and took them down a hallway to a testing room. Upon arrival in the testing room, the RA explained the (bogus) *photograph description task*: participants were lead to believe that they were participating in a memory-recall task, in that they would be required to recall the details of the photographs being described to them in a questionnaire following the task. The participants were then asked to read and sign a consent form that further elaborated on this cover story. Following informed consent, the RA handed the

Fig. 4. The experimental room set-up. The two-camera recording output from Noldus video recording system. The research assistant and the participant sat facing each other while describing photographs to one another. The camera set-up allowed for the recording of all the movements shared between the pair.

participant 8 photographs that were facing down, and kept 8 photographs to herself. The participant was asked not to look at their photographs, until it was their turn to describe the details of the image. The RA explained that without showing each other the photographs, they were about to take turns describing the images to one another. She then explained that she would start with her description first, in order to demonstrate the approximate amount of detail that is required for each photograph. For the rest of the experiment the RA and the participant took turns describing the photographs to one another. Throughout the photograph description task, the RA subtly mimicked or anti-mimicked the behaviours and mannerisms of the participant at either a short (3-5 seconds) or long (10 seconds) time delay, and using either specular or anatomical mimicry.

Following the photograph description task, the RA stepped outside of the room to retrieve the questionnaires for the participant. Upon returning to the room, the RA dropped ten pens and waited for the participant to pick them up. After 7-10 seconds if there were still pens on the floor, the RA would retrieve them. This prosociality measure has been used in the mimicry literature in the past and is a direct measure of helping behaviour (Van Baaren, et al., 2004). The RA then asked the participants to fill out the questionnaire, and left the room to keep participant's responses confidential.

Questionnaire Measures

Affiliation Measure. Affiliative judgements were assessed using questions similar to those used in past studies (Lakin & Chartrand, 2003; Hogeveen, et al., 2014). Specifically, on a 5-point *Likert* scale, the participants were asked to assess (a) How likeable was the experimenter during the photograph description task, (b) How smoothly would you say your interaction went with the

experimenter during the photograph description task, and (c) Would you want to spend more time with the experimenter to get to know her better.

Inclusion of Others in Self (IOS). Venn-like diagrams of two circles were used to assess how interconnected people feel with others in general (Aron, Aron & Smollan, 1992).

Debriefing

After completing all questionnaire measures, participants underwent a thorough funnelled debriefing procedure with the experimenter. They were probed for (a) general suspicions, (b) what they thought the purpose of the study was, (c) whether they noticed anything specific about the photograph description task and whether, during the photograph description task, they noticed any specific mannerism conducted by the RA. Following funnelled debrief, the participants were fully debriefed about the true purpose of the study.

None of the participants correctly guessed the true purpose of the experiment, and neither did they report being aware of the mimicry being conducted by the RA.

Results

Social affiliation judgements. We were interested in exploring whether a temporal delay (short, long) or a particular type of mimicry (anatomical mimicry, specular mimicry, anti-mimicry) had an effect on affiliative judgements of an interaction partner. To address this question, a 2x3 ANOVA on composite affiliative scores yielded a significant temporal delay by mimicry type interaction $F(2, 84) = 3.24$, $p = .04$, $\eta^2p = .07$.

Independent samples t-tests were employed to further investigate this interaction. First, for the participants in the *anatomical mimicry condition*, those experiencing mimicry at *short time* delay (M=4.53, SD=.50) evaluated the research assistant more positively than the participants in the *long-time* delay condition (M=4.18, SD= .43; t(28)= -2.08, p = .047, d= -.76; **Fig. 5a**). For the participants in the *specular mimicry condition,* those experiencing mimicry at *short time* delay evaluated the research assistant less favourably (M=4.02, SD= .50) than the participants in the *long time* delay condition (M=4.40, SD= .44; t(28) = 2.17, p=.039, d= .79; **Fig. 5b**). Finally, for the participants in the anti-mimicry condition, there was no effect of time delay, t(28)= .087, p = .93, d= .03, **Fig 5c**.

Inclusion of Others in Self (IOS) Scale. The IOS scale was coded from 1 (non-overlapping circles) to 7 (most-overlapping circles), with the 1 indicating low closeness with others. A 2x3 ANOVA on IOS score did not yield a significant interaction between temporal delay and mimicry type conditions, F (2, 84) = 1.85, p= .16, η^2p = .04.

Behavioural Prosociality Test. We were interested in whether participants in any of the mimicry conditions would pick up more pens when they were dropped by the research assistant post-mimicry manipulation, and whether this effect would be mediated by temporal delay. As previously, it has been suggested that the pen drop method is a measure of prosociality (Van Baaren et al., 2004). A 2x3 ANOVA on number of pens that were picked up off of the floor did not show a significant interaction of temporal delay and mimicry type conditions, F(2, 84) = 1.91, p= .15, η^2p = .04. The simple main effects of mimicry type (F (2,84) = .59, p = .56, η^2p

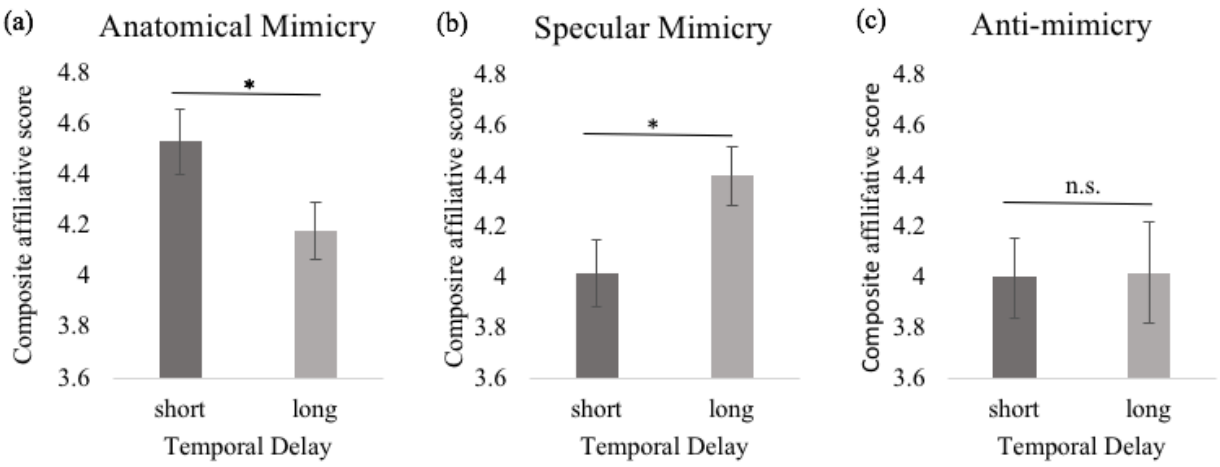

Fig. 5. Composite Affiliation Judgement of Confederate. Composite affiliation ratings for the confederate following **(a)** anatomical mimicry condition, **(b)** specular mimicry condition and **(c)** anti-mimicry condition at the two different temporal delays. *Error bars* are depicting between-subject standard errors

=.01) and temporal delay (F (1, 84) = .85, p = .36, η^2p = .01) on the number of pens picked up were also non-significant.

Discussion

Our results indicated that there is a significant interaction between type of mimicry conducted and the temporal delay of the mimicking behaviour. Upon further analysis of the interaction, it was determined that anatomical mimicry lead to significantly higher positive evaluation of the research assistant at short time delays compared to long time delays. In contrast, specular mimicry lead to significantly higher positive evaluation of the research assistant at long time delays compared to short time delays. Finally, anti-mimicking did not lead to a significant difference in affiliative perceptions of the confederate between the two time delays.

Our results show that that the relationship of the mimicker's effector (*different* in specular mimicry vs *identical* in anatomical mimicry) to the mimickee's effector interacts with the time delay to affect affiliative judgements of the mimicker. Specifically, we suggest that anatomically identical movements within a short time delay are registered as mimicry and contribute to the increased liking for the interaction partner. We further suggest that traditionally defined mimicry (mimicking behaviour within 3-5 seconds of original movement) might exert its prosocial effects due to the activation of overlapping self-other motor representations (i.e. for identical effector movement). The self-other overlap reinforces the sense of inter-connectedness between the interacting pair by fostering a psychological sense of similarity. In fact, as previously mentioned, it has been proposed that the mirror neuron network provides the

neurological mechanism for the self-other mapping and consequently the manifestation of mimicking behaviours (Pineda, 2009).

In contrast, specular mimicry within a short time delay does not lead to increased liking of the interaction partner, suggesting that it is not registered as traditional mimicry. Perhaps, at a short time delay, specular mimicry is not registered as 'mimicry', and thus does not cause an overlap in self-other representation in the motor cortex. However, at a longer time delay, specular mimicry does lead to increased liking of the interaction partner. We suggest that this long latency specular mimicry effect on liking is not mechanically related to what has typically been thought of as mimicry. Perhaps, whereas traditional mimicry is coded in the motor coordinates (i.e. anatomically identical movements), this new type of mimicry is coded in external spatial coordinates (i.e. identical movements made on the same side of external space). In the latter case, the movements are motorically different (i.e. different effector), but not externally spatially different.

From the findings of this study, we suggest that other than the typically defined mimicry (i.e. occurring within 3-5 seconds), another form of mimicry exists – we call it *long- form mimicry*. Rather than the short latency self-other motoric overlap, as seen in anatomical mimicry, this long-form mimicry codes for the external-spatial relationship between actions, and it doesn't appear to depend on short-latency self-other overlap mechanism. These findings are novel in nature, and future research should explore this new form of mimicry using some of the traditional mimicry manipulations.

Experiment Three

Introduction

In experiment three, we attempted to replicate the findings from an experiment by Hogeveen et al. (2015) using transcranial direct current stimulation (tDCS). tDCS is a form of neurostimulation that delivers a constant, low current to the cortical area of interest via electrodes on the scalp (Nitsche & Paulus, 2000; Rosa & Lisanby, 2012). The cortical changes that result from tDCS are sustained even after stimulation has ended, and the duration of this change depends on the length of stimulation and the intensity of stimulation (Nische & Paulus, 2000). For example, previous studies have suggested that 13 minutes of active tDCS lead to neuromodulatory effects that last up to 90 minutes post-stimulation (Nitsche & Paulus, 2001; Hogeveen et al., 2015). Hogeveen et al. (2015) used anodal tDCS as part of their protocol. Anodal tDCS refers to a positive stimulation, which causes the targeted neurons to depolarize, enhancing neuronal excitability at the site of stimulation (Nitsche & Paulus, 2000). In their study, the researchers discovered that relative to sham and temporoparietal junction (TPJ) stimulation, anodal stimulation to the inferior frontal cortex (IFC) led to participants performing more mimicking behaviours during a social interaction with a confederate. In fact, IFC, along with the parietal cortex, is a component of the human mirror neuron system (Iacoboni et al., 1999), so it is not surprising that excitation to IFC led to an increase in mimicking behaviour. Moreover, it has also been suggested that in addition to IFC neurons involved in the mirror neuron system, there is a complementary set of IFC cells that control the influence of the mirror neuron system on behaviour (Kraskov et al., 2009). The finding of the Hogeveen et al. (2015) study that anodal stimulation to the IFC increases mimicking behaviours compared to sham and TPJ stimulation supported the claim that the IFC plays a role in imitative control.

Although the discovery of increased mimicking behaviour in a social interaction after anodal tDCS to the IFC in the Hogeveen et al. (2015) study was interesting, it was not the central finding of their paper. The researchers treated another two studies they ran as part of their research protocol as their primary findings. Thus, in our third experiment, we were interested in seeing whether we can discover similar results to their social mimicry findings. Along with sham stimulation, we delivered anodal tDCS to two brain regions: inferior frontal cortex and visual cortex (control site). There was another minor change to the protocol; unlike in the original study, we were interested in investigating whether anodal stimulation to the IFC would lead to more mimicking behaviours in a subsequent *video* task, rather than in a social interaction with a confederate. The participants were instructed to watch a video of a female model describe a set of pictures. As she was describing the pictures, the female model would touch her face once in a while, and we were looking for mimicking face touches from the participant. Similar video recording set up has been shown to lead to increased mimicking behaviours as a result of various manipulations in the past (Latkin and Chartrand, 2003; Martin, Gueguen & Fischer-Lokou, 2010; Kavangh, Suhler, Churchland & Winkielman, 2011). Following the video task, we collected data on affiliative judgement of the female model, to see if the participants preferred the female model in one of the stimulation conditions more than others. We hypothesized that similar to the findings of Hogeveen et al. (2015), anodal stimulation of the IFC would lead to more mimicking behaviours, and that as a result of those mimicking behaviours, participants would report higher affiliative judgements of the model in the IFC condition compared to the other two stimulation conditions.

Methods

Participants

Sixty participants, aged between 17 and 25, were recruited from an introductory psychology research pool at McMaster University. For 7 of the 60 participants, the impedance was not strong enough to continue with the experiment, thus leaving 53 (45 female, M_{age}= 18.39) participants for data analysis. The study was approved by the local research ethics board and each participant provided informed consent prior to the start of the experiment. Prior to arrival for the experiment, the participants were assigned to one of three tDCS stimulation conditions: IFC (N= 18, 16 female, M_{age}=18.44), VC (N= 17, 15 female, M_{age}= 18.47) or sham (N= 18, 14 female, M_{age}= 18.28).

Materials:

The experimental room was equipped with Noldus video recording system. There were two cameras mounted on two walls of a 10 by 8 foot room, focused on recording the participant when they were sitting in front of the computer to watch the video recording (**Fig. 6).**

tDCS stimulation was delivered via a battery driven, constant current stimulator (Neuroelectrics) by a pair of surface sponge electrodes (25 cm^2), soaked in a saline solution (0.9%, NaCl), and applied to the scalp at target areas.

Procedures

tDCS procedures: Participants were brought into the testing room from a designated waiting area. They were told that they were going to participate in a study examining the effects of tDCS

Fig. 6. The room set-up for video task. The two-camera recording output from Noldus video recording system. The participant sat in front of a computer screen while watching a pre-recorded video of a female model. The Noldus camera set-up recorded the movements performed by the female model as well as the movements performed by the participant.

brain stimulation on subsequent memory recall. All participants read a tDCS information sheet and verified that they did not have any contradictions to tDCS. They were then asked to read and sign a consent to participate in the study form. After obtaining written consent, participants were led to an arm chair, where the experimenter put a tDCS cap on the participant. The cap was pre-marked according to the standard 10/10 system with the stimulation locations: FC6 (IFC), OZ (VC) and the vertex. For IFC stimulation, the anodal electrode was placed on FC6 and the return electrode on the vertex; for VC stimulation, the anode was placed on OZ and the return electrode on the vertex, the sham condition was split evenly between the two electrode montages. For active tDCS stimulation, 15s ramp up period was followed by 20 minutes of 1 mA stimulation and 15s of ramp-down period. For sham stimulation, the same ramp-up/ ramp-down procedures were administered along with 30s stimulation period, however the participants were nonetheless lead to believe that the stimulation was taking place for 20 minutes, in order to provide a similar experience to real stimulation conditions. During the stimulation, the participants were instructed to 'sit back in the arm chair and relax, close your eyes, and try not to think about anything specific', these instruction are in line with previous research (Hogeveen et al., 2015).

Mimicry Task Procedures: Following the 20 minute tDCS stimulation, the experimenter excused herself to go and get the questionnaire sheets. When the experimenter re-entered the room, she dropped a box of pens in front of the computer table, and waited 10s before picking up the pens. The number of pens the participant picked up was taken as a measure of prosociality. Next, the experimenter instructed the participants to watch a video of a girl, who described a set of pictures to them, after which they would fill out a questionnaire regarding the video. In the video, while describing the photographs, the female model would casually touch her face (23 times in total).

If the participant, touched their face within 3-5 seconds of the female in the video, the movement was considered a *mimicking behaviour.* Following the findings of experiment two, we also made a post-hoc decision to look at the mimicking behaviours displayed by participants within 10 seconds after the female model's original face touch. After the video was finished, and the participant filled out the questionnaires, the experimenter re-entered the room.

Questionnaire Measures:

Affiliation Measure. Affiliative judgements were assessed using questions similar to those used in past studies (Latkin & Chartrand, 2003; Hogeveen, et al., 2014). Specifically, on a 5-point *Likert* scale, the participants were asked to assess (a) How likeable was the experimenter during the photograph description task, (b) How smoothly would you say your interaction went with the experimenter during the photograph description task, and (c) Would you want to spend more time with the experimenter to get to know her better.

Inclusion of Others in Self (IOS). Venn-like diagrams of two circles were used to assess how interconnected people feel with others in general (Aron, Aron & Smollan, 1992).

Debriefing

The participants underwent a thorough funnelled debriefing procedure with the experimenter. They were probed for (a) general suspicions, (b) what they thought the purpose of the study was, (c) whether they noticed anything specific about the video and whether, (d) during the video they noticed any specific mannerism conducted by the female model. Following this funnelled debriefing procedure, the participants were fully debriefed about the true purpose of the study.

None of the participants correctly guessed the true purpose of the experiment.

Results

Mimicking Behaviours Data

A between-subjects ANOVA on the number of mimicking behaviours conducted within 3-5 seconds of the video model's face touch did not yield a significant effect of stimulation site (IFC, VC, sham), $F(2, 50) = .63$, $p = .54$, $\eta^2p = .02$.

A between-subjects ANOVA on the number of mimicking behaviours conducted within 10 seconds of the video model's face touch also did not yield a significant effect of stimulation site, $F(2, 50) = .75$, $p = .48$, $\eta^2p = .03$.

Affiliative Data

We were interested in whether the female model would be rated more positively by the participant in the IFC stimulation condition. To test this question, a between-subjects ANOVA with the stimulation (IFC, VC, sham) as a factor was conducted on the composite affiliative scores obtained from the questionnaire. The ANOVA did not yield a significant interaction between the composite affiliative score and stimulation condition type ($F(2, 50) = .45$, $p = .64$, $\eta^2p = .18$).

IOS Data

The IOS scale was coded from 1 (non-overlapping circles) to 7 (most-overlapping circles), with the 1 indicating low closeness with others. A between-subjects ANOVA on IOS score did not

yield a significant interaction between the three stimulation conditions, $F(2, 50) =. 22$, $p = .80$, $\eta^2p = .009$.

Discussion

We were interested in seeing whether we can get a similar result to the one obtained by Hogeveen et al. (2015). Specifically, we set out to determine whether anodal stimulation to the inferior frontal cortex would lead to increased mimicking behaviour when compared to a control site and sham stimulation. Following stimulation, instead of engaging in a real time interaction with a confederate, as outlined in the original protocol, we had the participants watch a video of a female model describing pictures who would casually touch her face once in a while. Using this altered paradigm, we were unable to confirm a similar pattern of results to those reported by Hogeveen et al. (2015). Participants did not display more mimicking behaviours following tDCS to the IFC when compared to control site (visual cortex) or sham stimulations.

There are a number of possibilities for why the results we obtained are not similar to the ones previously reported. First, while watching the video recording, the participants were left alone in the room. Other than self-motivation to perform well on the memory task, there was no one in the room to motivate them to focus on the video throughout the task. Similarly, upon video review, it was determined that those participants who did focus on the video, often closed their eyes or looked away from the screen, perhaps to 'imagine' the pictures that were being described to them. In these scenarios, it would be impossible for participants to 'mimic' the female model if they are not paying attention to the movements she is performing. In either case, it would be beneficial to alter the study protocol to have an experimenter in the room while the participants are watching the video, to keep them focused on the task at hand, and leave the room

once the video finishes. Of course, it could also be the case that the results found by Hogeveen et al. (2015) are simply not replicable, but that is unlikely since other researchers have also implicated IFC in imitative behaviours (Iacoboni et al., 1999; Heiser et al., 2003; Brass et al., 2005; Catmur et al., 2009). Thus, it would be worthwhile to run this study again implementing the changes to video protocol or simply re-running the tDCS study where the participant is interacting with a confederate, rather than watching a video, following stimulation.

General Discussion

There is an abundance of literature support for the affiliative effects of behavioural mimicry following social interactions (Chartrand & Latkin, 2013; also see Obhi (2016) for a review). However, mimicry research has focused on investigating these effects within the dyad. The work presented in this thesis, investigated the downstream effects of behavioural mimicry in a broader social environment by introducing another mimicking source. We also explored the impact of timing and type of mimicry on affiliative judgements of the mimicker and we attempted to replicate a previous study that aimed to demonstrate a causal link between the inferior frontal cortex and the production of mimicking behaviours.

In experiment one, we showed that mimicry emanating from outside of the interacting dyad has an impact on how the interacting partner, within the dyad, is perceived. Knowing that mimicry within the dyad affects affiliative perceptions of one another (Chartrand and Bargh, 1999), and due the fact that priming studies in different modalities show that information can be processed without awareness and can impact subsequent cognitive processes (Corteen & Dunn, 1974; Von Wright, Anderson, & Stenman, 1975; Chambon & Haggard, 2012), we predicted that mimicry emanating from a third person would impact how the participant perceives their

interaction partner. Our results showed that when the participant is anti-mimicked by another individual, who is not their interaction partner, they perceive their interaction partner as more likeable than when they are mimicked by the third person. We suggested that a contrast takes place, between the mimicry emanating from (1) the third person and (2) the interaction partner, and proposed an existence of a brain mimicry detection mechanism that filters mimicry information in the whole social environment prior to forming affiliative judgements about the interaction partner.

In experiment two, we showed that *timing* and *type* of mimicry interact in an interesting manner that impacts the way we perceive our interaction partner. We had participants engage in a photograph description task with a research assistant who engaged in either anatomical mimicry, specular mimicry, or anti-mimicry of their behaviour at either a short (3-5 second) or a long (10 seconds) time delay. Some researchers have suggested that temporal contingency rather than motor similarity of movement may lead to the affiliative results often reported in the mimicry literature (Catmur & Heyes, 2013; Dignath, Lotze-Hermes, Farmer & Pfister, 2017). From the traditional mimicry definition (mimicry occurs when two or more people engage in the same behaviour within 3-5 seconds of each other; Chartrand & Latkin, 2013) it is unclear whether timing or mimicry type lead to the affiliative results. We predicted that motor similarity at short time delay would lead to higher affiliative results than motor dissimilarity at long time delay and that anatomical mimicry would lead to a more positive evaluation of the partner than specular mimicry. Our results showed that: (1) anatomical mimicry at short time delay leads to higher affiliative score than anatomical mimicry at long time delay, that (2) specular mimicry leads to higher affiliative score at long time delay than short time delay, and that (3) regardless of time delay anti-mimicry leads to the same affiliative score. Based on these findings, we

suggested that there are two different forms of behavioural mimicry that employ different coding mechanisms. We proposed that what has traditionally been defined as behavioural mimicry, is in fact anatomical mimicry at short time delay. The positive feelings that arise toward the interaction partner in anatomical mimicry at short latency manifest as a result of self-other overlap of motorically identical movement. In contrast, we suggest that specular mimicry at long time delay is a different form of mimicry. The increased affiliative feelings toward the interaction partner arising from specular mimicry at long latency may be due to similarity of movement on the same side of external space; and thus the coding occurs in terms of external spatial coordinates rather than in terms of anatomically similar motor coordinates.

In experiment three, we were unable to find support for the finding that transcranial direct current stimulation (tDCS) to the inferior frontal cortex (IFC) leads to more mimicking behaviours in a subsequent behavioural task when compared to stimulation at a different (control) site or sham stimulation. Following anodal tDCS stimulation to the IFC, the visual cortex (VC) or sham stimulation, we had participants watch a video recording of a female model who, at naturally spaced increments, touched her face. We predicted that the participants would touch their face more following the model's movement in the IFC stimulation condition compared to VC or sham stimulation. Our results did not reflect our prediction; there was no difference between conditions in the amount of mimicking behaviour exhibited by the participants. We suggest that our results were due to the nature of the video task, rather than lack of impact of stimulation to the IFC on mimicking behaviours, and that it would be beneficial to run this study again with either more specific video task instructions or with an interaction partner, rather than a video task.

In sum, the present research demonstrates that the human detection and recognition systems for behavioural mimicry are far more advanced than previously thought. We were able to demonstrate that people's conceptions of their interaction partners can be shaped by the behaviours of others in the room, who themselves are not involved in the interaction. This seems to happen without awareness and appears to involve a mimicry detection system that is sensitive to the contrast between the nature of mimicry being displayed by the interaction partner and the nature of mimicry being displayed by another source. Furthermore, we found that the recognition of mimicry is complex: short form anatomical mimicry and long form specular mimicry both lead to heightened affiliative feelings toward the interaction partner. We proposed that different coding mechanisms might underlie the affiliative effects of the two types of mimicking behaviours.

The experiments and results reported in this thesis are novel and include new discoveries such as the effects of third person mimicry on liking and the effects of mimicry type and timing on affiliation scores. However, future work is still needed to explore the complexity and intricacy of causes and consequences of human mimicry. For instance, based on the third-person mimicry results, it would be interesting to further explore the mechanisms involved with keeping track of mimicry behaviour in social environments. Would the affiliative judgements towards the confederate change if the confederate was also exhibiting mimicking/anti-mimicking behaviours at the same time as the third person (i.e. would the most optimal mimicking environment be a combination of a mimicking confederate and anti-mimicking third person)? Similarly, based on the timing of mimicry and type of mimicry results from experiment two, it would be interesting to explore the effects of these two types of mimicry with more timing conditions (i.e. 1-2 seconds, 3-4 seconds, 5-6 seconds, 7-8 seconds, 9-10 seconds after target behaviour), to pinpoint

exactly when anatomical mimicry and specular mimicry result in most affiliative judgments. Perhaps it would also be interesting to see what type of mimicry people engaging in naturally when interacting with others – is anatomical or specular mimicry more common for individuals to display in interactions? For example, we know that a goal to affiliate leads to more mimicry (Latkin and Chartrand, 2003), but is it anatomical mimicry, specular mimicry or a combination of both that people tend to engage in to accomplish this goal? Evidently, there are still a lot of questions that require in depth investigation, and the work reported in this thesis opens up avenues for future researchers to pursue.

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