Impression or expression?

The influence of self-monitoring on the social modulation of motor contagion

James W. Roberts, Simon J. Bennett, & Spencer J. Hayes*

Brain and Behaviour Laboratory

Tom Reilly Building, Faculty of Science

Liverpool John Moores University,

Liverpool, UK,

L3 3AF

Running head: Self-monitoring and social modulation

*Corresponding author

Spencer J. Hayes

Brain and Behaviour Laboratory,

Tom Reilly Building, Faculty of Science,

Liverpool John Moores University,

Liverpool, UK, L3 3AF

S.Hayes@ljmu.ac.uk

Abstract

Social primes (pro-social, anti-social) can modulate mimicry behaviour. To date, these social modulation effects have been explained by the primed incentive to affiliate with another (Social Top-Down Response Modulation; STORM) and the primed active-self-concept leading to behaviour that is either consistent or inconsistent with the prime-construct (Active-Self account). The present study was designed to explore the explanatory power for each of these accounts, and thereby gain a greater understanding of how social modulation unfolds. To do this, we assessed social modulation of motor contagion in individuals high or low in self-monitoring. It was reasoned that high self-monitors would modulate mimicry according to the primed social incentive, whereas low self-monitors would modulate according to the primed active-self-concept. Participants were primed with a pro-social and anti-social cue in the first-person and third-person perspective. Next, they completed an interpersonal observation-execution task featuring the simultaneous observation and execution of arm movements that were either congruent or incongruent to each other. Results showed increased incongruent movement deviation (motor contagion) for the anti-social compared to the pro-social prime in the high self-monitors only. Findings support the STORM account of mimicry by showing observers modulate behaviour based on the social incentive underpinning an interpersonal exchange.

Keywords:

motor contagion, social modulation, top-down, active-self, self-monitoring

Introduction

Observing an action can influence the physical execution of that same action (Bekkering, Wohlschläger, & Gattis, 2000; Brass, Bekkering, Wohlschläger, & Prinz,, 2000; Castiello, 2003; Dijkerman & Smit, 2007; Kilner, Paulignan, & Blakemore, 2003; Mattar & Gribble, 2005; Welsh et al., 2005). For example, when primed to execute a finger/grasp response via a numeric cue (Brass et al., 2000; Liepelt, von Cramon, & Brass, 2008) or change in stimulus configuration (Cook, Press, Dickinson, & Heyes, 2010; Press, Bird, Flach, & Heyes, 2005; Press, Gillmeister, & Heyes, 2007), participants respond faster when an observed action is congruent, as opposed to incongruent, with their own response action. The differences in response times have been associated with lower-level sensorimotor processes that underlie imitation and mimicry. The notion is that an observer maps an observed action onto a corresponding sensorimotor response code (i.e., visuomotor priming), which facilitates the execution of the same action, or interferes with the execution of an alternative action (Blakemore & Frith, 2005; Heyes, 2010; Hommel, Müsseler, Aschersleben, & Prinz, 2001; Prinz, 1997; Rizzolatti & Sinigaglia, 2010).

Mimicry behaviour associated with the difference between observed congruent and incongruent action stimuli can be modulated by priming observers with pro- or anti-social attitudes (Leighton, Bird, Orsini, & Heyes, 2010). Using a scrambled sentence task, Leighton et al. (2010) showed pro-social primes (e.g., 'She is my friend') increased mimicry compared to anti-social primes (e.g., 'They are our enemy'). In addition, the involuntary mimicry of actions during a naturalistic interpersonal exchange increased following a pro-social compared to an anti-social prime (van Baaren, Maddux, Chartrand, de Bouter, & van Knippenberg, 2003). The influence of social processes on the coupling between perception and action during mimicry may be explained by the Social Top-down Response Modulation (STORM) account (Wang & Hamilton, 2012), which suggests that observers activate a

strategic incentive to facilitate social interactions with other agents, thus leading to positive social affect. More specifically, a social prime may activate a goal to affiliate with another individual, such that the observer involuntarily adopts mimicry in order to achieve this social goal. In this instance, mimicry is adopted because observers enhance their chances of being liked or favoured by the individual being mimicked (Chartrand & Bargh, 1999).

Because the STORM account suggests that mimicry is contingent upon an observer's goal to affiliate, mimicry behaviour is modulated according to the context in which an interpersonal exchange unfolds. For example, the initial failure to affiliate with another individual (Lakin Chartrand, 2003), or when becoming excluded from group-based tasks (Lakin, Chartrand, & Arkin, 2008; Over & Carpenter, 2009), can increase involuntary mimicry. Moreover, when presented with an anti-social compared to a pro-social prime, observers produced increased mimicry effects when interacting with a human model stimulus (Roberts, Bennett, & Hayes, 2016). In these anti-social instances, it was suggested that prior to an interpersonal exchange, an observer may have already established a specific goal to affiliate with another individual (see Miles, Nind, Henderson, & Macrae, 2010). Thus, in the event there is a perceived threat to obtaining this goal during the interpersonal exchange (e.g., anti-social context), an observer may enhance mimicry in order to accommodate for such a loss. In this regard, mimicry is adopted in an attempt to achieve positive social affect within the individual being mimicked, although when initially threatened the mimicry may be more accurately described as a process of restoring social harmony.

Using a similar stimulus-response procedure as Leighton et al. (2010), Wang and Hamilton (2013) concluded in favour of an alternative Active-Self account to explain the social modulation of behavioural mimicry. Mimicry was found to increase following pro-social primes compared to anti-social primes when self-related pronouns were also presented (e.g., 'I', 'we'), whereas mimicry was greater following anti-social primes compared to pro-

social primes (Experiment 2) when third-person nouns were presented (e.g., 'Joe', 'Greg'). These findings were suggested to manifest from a role of the active-self-concept, which refers to a transient and readily accessible form of the 'self', and is a subset of the chronic self-concept, which refers to an invariant and long-term representation of the 'self' (Wheeler, DeMarree, & Petty, 2007). The influence of primes on behaviour can be determined by whether the prime-construct assimilates or contrasts with the active-self-concept. That is, while primes make certain social information accessible, it is how the information is processed by an observer in relation to the 'self' that modulates the direction of mimicry. With regards to the findings of Wang and Hamilton (2013), the impact of social primes on mimicry was contingent upon whether the primes assimilated with the pro-social self-concept during first-person presentation, or contrasted during the third-person presentation. To elucidate, the pro-social prime from the first-person perspective may have assimilated with the pro-social self-concept, which then elicited mimicry behaviour consistent with the primed-construct (pro-social). When the pro-social prime was taken from the third-person perspective, it did not contrast with the pro-social self-concept, and thus generated less mimicry. For the anti-social prime that was taken from the first-person perspective, there was no assimilation with the pro-social self-concept, which limited mimicry. However, when the anti-social prime was taken from the third-person perspective, it likely contrasted with the pro-social self-concept, which then generated prosocial mimicry as a form of behaviour that was inconsistent with primed-construct (anti-social).

Because of the proposed role of the active-self-concept, it is reasonable to consider whether the social modulation of mimicry is influenced by individual differences in perceiving and implementing self-related information. Indeed, a characteristic feature of the 'self' is *self-monitoring*, which refers to a process of monitoring and adapting one's behaviour in accordance with the situational context (Snyder, 1974; Snyder & Gangestad,

1986). High self-monitors demonstrate increased sensitivity to situational cues and are more adept at changing their own behaviour to fit into social environments (i.e., persons of *impression*).[1] Low-self-monitors demonstrate increased sensitivity to dispositional cues such that behaviour is more consistent with their own feelings and beliefs (i.e., persons of *expression*).

To date, evidence suggests there is a greater tendency to mimic one's peers (e.g., fellow undergraduate student) compared to non-peers (e.g., high school student) in high self-monitors, but not in low self-monitors (Cheng & Chartrand, 2003). Moreover, there is a positive relationship between self-monitoring scores (higher scores indicating high self-monitoring) and the mimicry of facial expressions that generate positive social affect (i.e., laughing), but not for expressions generating negative social affect (i.e., frowning) (Estow, Jamieson, & Yates, 2007). Consistent with the STORM account, these findings suggest that high self-monitors more readily interpret social primes as situational cues, which leads to greater social modulation compared to low self-monitors. Therefore, social modulation of mimicry behaviour can unfold because an observer seeks to create an *impression*.

Alternatively, when priming individuals to a number '7' (priming feeling of lucky), compared to number '13' (priming feeling of unlucky), there is a greater tendency to interpret non-word masks as lucky-related words in low self-monitors, but not in high self-monitors (Experiment 2; DeMarree, Wheeler, & Petty, 2005). This finding suggests that low self-monitors more closely reflect their own feelings, and the associated primed-construct, compared to high self-monitors (Wheeler et al., 2007). Thus, based on the Active-Self account, it could be that low self-monitors perceive social primes as dispositional cues, which leads to increased social modulation compared to high self-monitors. In this regard, the social modulation of mimicry behaviour unfolds as a form of *expression*.

To date, both the STORM and Active-Self accounts have contributed to our understanding social modulation of mimicry behaviour. Thus, the aim of the present study is to further examine these theoretical accounts by exploring the influence of self-monitoring, which predicts different outcomes for each of these respective accounts. In our previous work on social modulation (Roberts, Bennett et al., 2016), observers executed horizontal arm movements while concurrently observing a congruent horizontal, or an incongruent curvilinear, human arm movement. Social context was primed using pro-social or anti-social words. Similar to the results of Wang and Hamilton (2013), we showed greater motor contagion (as indicated by greater orthogonal movement deviation for incongruent compared to congruent stimuli), and therefore mimicry, following anti-social compared to pro-social primes (N.B., without manipulating person-perspective). To extend this work, we used a similar interpersonal protocol to examine mimicry in high and low self-monitors (Snyder & Gangestad, 1986) when primed with anti-social and pro-social primes from a first or third-person perspective.

Figure 1 illustrates the hypotheses and predicted behavioural outcomes associated with STORM and Active-Self accounts of social modulation. Firstly, it is predicted that there will be greater deviation away from the intended direction of movement and toward the orthogonal axis during the observation of incongruent compared to congruent movement stimuli (i.e., motor contagion or mimicry effect), irrespective of social information (see Kilner et al., 2003; Roberts, Hayes, Uji, & Bennett, 2015). In accord with the STORM account, we predict there to be increase in motor contagion following an anti-social compared to pro-social prime (i.e., social modulation effect) (Roberts, Bennett et al., 2016), which will be greater in high self-monitors compared to low self-monitors. Because the STORM account does not specify how self-related information influences social modulation, it could be expected that there will be no significant change in the social modulation effects (pro-social

vs. anti-social) when first- or third-person perspective primes are presented. Alternatively, based on the Active-Self account, we predict that there will be increased motor contagion following a pro-social compared to an anti-social prime in the first-person perspective (Wang & Hamilton, 2013), and increased contagion following an anti-social compared to the pro-social prime in the third-person perspective, with these effects being greater in low self-monitors compared to high self-monitors.

[Insert Figure 1 about here]

Method

Participants

Data was recorded from thirty-eight participants (age range of 18-21 years), although one participant was removed due to recording errors (high self-monitoring n=19, low self-monitoring n=18). All participants had normal or corrected-to-normal vision and gave written informed consent prior to participation. The experiment was designed in accordance with the Declaration of Helsinki and was approved by the local ethics committee of the host university.

Apparatus and Materials

The stimulus display was back-projected (Hitachi CP-X345) on a flat white screen (2.74 x 3.66 m) at a viewing distance of 1.9 m. Pre-recorded video-clips were edited using Adobe Premier CS5 software, and later presented using the COGENT toolbox implemented in MATLAB (Mathworks, Inc). Movements were recorded at 200Hz from an infrared sensor positioned on the tip of the right index finger using a 3D Investigator Motion Capture system (Northern Digital Inc., Ontario, Canada). The first and last 5 s of data recordings were

discarded to minimize asynchrony around movement onset, and the potential influence of attentional and fatigue effects (see Hardwick & Edwards, 2012; Roberts, Hayes et al., 2015).

A scrambled-sentence task was used to prime a social attitude and consisted of an A4 four-page booklet with six partially formed sentences on each page. Self-monitoring was measured using the 18-item self-monitoring scale (Snyder & Gangestad, 1986). Participants responded to each item with true ('T') or false ('F'). Before calculating the sum of the scores for each participant, ten items were reverse-scored, with high scores indicating high self-monitoring, and low scores indicating low-self-monitoring. The groups were differentiated by a median split of the self-monitoring scores (e.g., Cheng & Chartrand, 2003).

Stimuli

The visual stimuli consisted of a human model that moved the right arm cyclically across the mid-line of the body with a horizontal, or curvilinear, trajectory for 30 s. The model stimuli were scaled so participants approximated a 400 mm horizontal displacement for each individual movement segment (i.e., left-to-right, right-to-left). While the horizontal stimuli followed a relatively straight horizontal movement trajectory, the curvilinear stimuli featured predominant horizontal amplitude with an added vertical component, which peaked at around the midsagittal axis. Thus, the curvilinear movement end-points aligned with those of the horizontal stimuli, but the movement trajectory was different (see Roberts, Hayes et al., 2015; Sparks, Douglas, & Kritikos, 2016). There were two model stimuli for each of the horizontal and curvilinear trajectories. The movements were well practised by the models so that the required movement amplitude and segment frequency of 1 Hz was accurate and consistent. Finally, the control condition consisted of a static display of the human model with a red fixation dot positioned at screen centre. The control condition was designed to

ensure there was no attention or muscular fatigue effects from performing continuous horizontal arm movements across trials.

Task and Procedure

Upon entering the lab, participants performed two tasks: a scrambled-sentence task and motor task. For the scrambled-sentence task, participants were instructed that the task was designed to assess how colour influences language proficiency (Leighton et al., 2010). In this task, participants had to carefully combine a selection of five different coloured words with already selected words to form a comprehensive sentence (adapted from Wang & Hamilton, 2013) (see Figure 2). When accurately formed, the sentences reflected pro-social (e.g., 'help') or anti-social (e.g., 'fight') behaviours in a first- (e.g., 'I') or third-person (i.e., 'Chris') perspective. To check the sentences were accurate, and to ensure participants acknowledged the prime-constructs, they read the sentence aloud. The motor task involved participants executing cyclical horizontal arm movements across the mid-line of the body. Prior to the test phase, participants practised (x 2 trials) performing the required arm movements by executing horizontal movements between two static targets positioned on the left and right side of the screen and in-time with a 1 Hz auditory metronome (i.e., one arm movement segment per auditory tone; 2 Hz movement cycles). The target dots and auditory metronome were then removed prior to the test phase. Participants would execute the same arm movements whilst fixating on a stationary dot (control), or in-time with a horizontal or curvilinear movement stimulus (experimental conditions).

During the experimental conditions, participants completed one sentence on the scrambled-sentence task before executing a trial of the motor task. There were six trials for each of the movement stimuli per block, with each block primed by a pro-social or anti-social context from the first-person or third-person perspective. The block order was counter-

balanced across participants. Within each block of trials, the model stimuli were pseudo-randomly presented with the caveat that no stimulus could be presented on more than two consecutive trials. For a single participant, the pro-social prime-construct was assigned to one model and the anti-social was assigned to the other (e.g., pro-social for 'Model A', anti-social for 'Model B'). The assignment of model stimuli to prime-constructs was counter-balanced across participants. Finally, the control trials were presented at the start and end of the trial order in order to assess the potential of attention and muscular fatigue effects. Following the observation-execution task, participants completed the 18-item self-monitoring questionnaire (Snyder & Gangestad, 1986). The delivery of the questionnaire toward the end of the experiment ensured participants did not raise any suspicions surrounding the overall purposes of the experiment, nor bias their response during the motor task.

[Insert Figure 2 about here]

Data reduction and analysis

Arm position data were low-pass filtered at 10 Hz using an autoregressive filter implemented in MATLAB. Individual movement segments were determined by identifying the reversal points of the primary movement axis (i.e., x-axis; horizontal). Standard deviation of the fingertip position within the orthogonal movement axis was extracted (i.e., y-axis; vertical) for each movement segment. Average deviation was calculated across movement segments of individual trials.

For the statistical analysis, we first performed a comparison (using Mann-Whitney U test due to unequal variance of the groups) between the ratings of self-monitoring in the high and low groups to ensure proper distinction for the category of self-monitoring (i.e., high > low). We then conducted a 2 self-monitoring (high self-monitors, low self-monitors) x 2 trial

number (start, end) mixed-design ANOVA on average deviation data of control trials in order to determine any attention and muscular fatigue effects. For experimental trial data, we conducted a 2 self-monitoring (high self-monitors, low self-monitors) x 2 stimuli (horizontal, curvilinear) x 2 prime (pro-social, anti-social) x 2 perspective (first-person, third-person) mixed-design ANOVA on average deviation with self-monitoring being the only between-measures factor. Significant effects featuring more than two means were decomposed using Tukey HSD post hoc procedure, and significant effects were declared at $p < .05$.

Results

The experimental control checks indicated that while participants were able to acknowledge the social component of the first- and third-person sentences, they were unable to infer any influence toward the interpersonal observation-execution task. They also believed that the instructions issued by the experimenter in the scrambled-sentence task were a test of language proficiency, and the interpersonal observation-execution task was a measure of motor control (Wang & Hamilton, 2013). The comparison between self-monitoring scores for the high and low groups indicated an appropriate characteristic split of the data ($W_s = 171.00$, $z = -5.22$, $p < .05$), with the high group (*mdn* = 11) reporting a significantly greater self-monitoring score than the low group (*mdn* = 6).

Movement deviation

The comparison of control trials revealed no significant main effect of self-monitoring $F(1, 35) = .58$, $p > .05$, *partial* $\eta^2 = .02$, or a self-monitoring by trial number interaction, $F(1, 35) = .43$, $p > .05$, *partial* $\eta^2 = .01$. There was a significant main effect of trial number, $F(1, 35) = 7.02$, $p < .05$, *partial* $\eta^2 = .17$, indicating a decrease in movement deviation across trials.

Therefore, any subsequent increase in deviation during the experimental trials would be specific to the stimulus conditions, rather than fatigue.

For the experimental trials, there was a significant main effect of stimuli, $F(1, 35) = 23.92$, $p < 0.05$, *partial* $\eta^2 = .41$, indicating greater deviation for the observation of incongruent stimuli compared to congruent stimuli. There was also a significant two-way interaction between stimuli and prime, $F(1, 35) = 4.94$, $p < .05$, *partial* $\eta^2 = .12$, and a three-way interaction between self-monitoring, stimuli and prime, $F(1, 35) = 5.06$, $p < .05$, *partial* $\eta^2 = .13$. As illustrated in Figure 3, there was less deviation for the incongruent stimulus when primed by the pro-social compared to the anti-social cues in the high self-monitoring group, but not the low self-monitoring group. There were no significant differences for the congruent stimulus across pro-social and anti-social cues in each of the self-monitoring groups. Finally, there was no significant main effect, nor an interaction featuring the factor of perspective (*ps* > .05).

[Insert Figure 3 about here]

Discussion

Extending upon previous work that showed mimicry is modulated by social primes (Cook & Bird, 2011; Leighton et al., 2010; Wang & Hamilton, 2013), the present study additionally examined the influence of self-monitoring during an interpersonal observation-execution task (Roberts, Bennett et al., 2016). Participants were primed by a pro-social or anti-social cue, presented in the first- or third-person perspective, prior to executing cyclical horizontal arm movements during the observation of congruent horizontal or incongruent curvilinear arm movements. In addition, participants were categorized as high or low in self-monitoring. Results showed greater involuntary movement deviation when observing the

incongruent stimulus following an anti-social prime compared to a pro-social prime, and that these effects were primarily found in the high compared to low self-monitors.

The social modulation effect shown in the current study is inconsistent with evidence showing greater mimicry following a pro-social compared to the anti-social prime (e.g., Cook & Bird, 2012; Leighton et al., 2010). However, they are in accord with the predictions of the STORM model (Wang & Hamilton, 2012), which suggests modulation effects courtesy of social primes are underpinned by the observer's interpretation of the social context. For example, anti-social primes can cause greater mimicry than pro-social primes in situations where the observer initially seeks affiliation (Roberts, Bennett et al., 2016). Thus, in a situation of perceiving an anti-social prime, an observer may increase their mimicry because it typically elicits positive social affect in the observed agent, while compensating for any initial deterioration in the social exchange (Lakin, Chartrand, & Arkin, 2008; Over & Carpenter, 2009). On the other hand, pro-social primes may produce greater mimicry than anti-social primes during situations of limited social context because the primes can begin to initiate a strategic incentive to affiliate. Taken together, the overriding incentive to accumulate affiliation, along with the subsequent use of mimicry in order to achieve this incentive, may represent the most common feature of all the empirical cases (e.g., Leighton et al., 2010; Roberts, Bennett et al., 2016) that lend support to the STORM account.

The above interpretation is supported by the fact that only high self-monitors demonstrated social modulation. High self-monitors are defined by their increased sensitivity and/or ability to detect and use situational cues to modulate subsequent behaviour. Consequently, high self-monitors may be described as persons of *impression*. Thus, the social primes presented in the current study seemed to be more readily accessible to high self-monitors who used this information to modulate mimicry in order to convey a certain impression of themselves. In the context of the STORM model, it may be that the increased

motor contagion following an anti-social compared to pro-social prime in high self-monitors, and not low self-monitors, resulted from an initial interpretation of an anti-social context, which renders a potential threat to achieving affiliation. As a result, high self-monitors showed greater mimicry because it is typically a process that can advance social outcomes (Chartrand & Bargh, 1999), while potentially overcoming any perceived disadvantages toward reaching social goals. This conjecture is consistent with evidence that shows high self-monitors mimic those they have a greater desire to affiliate with (e.g., fellow students) (Cheng & Chartrand, 2003), and when the action to-be-mimicked pertains to a positive social affect (e.g., laughing) (Estow et al., 2007).

Of interest, the greater social modulation effect in high self-monitors was underpinned by a down-regulation of motor contagion (inhibition) following a pro-social prime rather than an up-regulation (facilitation) following an anti-social prime. The direction of this effect is consistent with high self-monitors mimicking less than low self-monitors when primed to a position of power (i.e., leader), where there may be a reduced social incentive (Cheng & Chartrand, 2003). Moreover, high self-monitors decrease mimicry after they have experienced a successful interaction with the incentive to affiliate compared to having no incentive to affiliate (Lakin & Chartrand, 2003). Therefore, high self-monitors are just as likely to reduce mimicry in order to respond to situations where they do not need to generate pro-social behaviour, as well as situations where mimicry may be more strongly needed to achieve social gains. Alternatively, low self-monitors seem to mimic observed actions regardless of the situation or context. Therefore, why did high self-monitors find themselves inhibiting motor contagion following pro-social primes?

To address this, we consider the influence that mimicry has on the observed agent (person being mimicked) during interpersonal settings. Generally speaking, being mimicked increases the sense of liking and/or affiliation (Chartrand & Bargh, 1999, see Chartrand &

Lakin, 2013). However, mimicry is modulated by the specific context in which it unfolds. That is, mimicry beholds particular standards or expectancies surrounding the magnitude and frequency of its occurrence. For example, mimicry elicits colder feelings (i.e., the "chills"; indicator of negative social affect) when initially greeted with a formal affiliative demeanour compared to an informal non-affiliative demeanour (Experiment 1; Leander, Chartrand, & Bargh, 2012). In addition, mimicry causes colder feelings in independent individuals that are predisposed to greater social anxiety and avoidance, compared to interdependent individuals (Experiment 3; Leander et al., 2012). Thus, it appears that when the implicit standards of mimicry are contrasted (e.g., too much/too little mimicry), an adverse social affect manifests within the observer. In the context of the present study, the instruction to move in synchrony with the observed model may have generated an initial incentive to affiliate with the model. As a result, the pro-social prime may have heightened the social engagement, and therefore contrasted with the observer's implicit standards. That is, the observer may be cautious not to violate the expectations surrounding an unfamiliar interpersonal exchange, where too much mimicry may be misconstrued as suspicious (Leander et al., 2012). Presumably, high self-monitors would have prevented this from happening by attempting to decrease the amount of contagion (or mimicry). Notably, this pattern of modulation is consistent with the STORM account, which suggests the control of mimicry is contingent upon the perceived social context and individual incentive to affiliate. Therefore, high self-monitors may have been more sensitive to the perceived social context (e.g., social prime word), and thus able to modulate their motor contagion so not to diminish the social gains by producing too much (pro-social context) or too little (anti-social context) mimicry.

The alternative Active-Self account suggests that social modulation is related to how the perceived social primes either assimilate or contrast with the active-self-concept (Wang & Hamilton, 2013). Based on this particular account, it was predicted that the prime to person-

perspective (1st, 3rd) should influence the direction of social modulation with pro-social primes generating greater contagion than anti-social primes when taken from the first-person perspective (assimilation), and anti-social primes generating greater mimicry than pro-social primes when taken from the third-person perspective (contrast). However, the current findings indicate that there was no influence of person-perspective suggesting social modulation in our task occurs independent of the perspective in which the social prime was presented. In reconciling the reported effects of person-perspective for the current and previous studies (i.e., Wang & Hamilton, 2013), it is important to consider the differences between each of the experimental tasks adopted. Indeed, the current study required observers to synchronize their movements with another human agent, which may activate a prior social incentive (Miles et al., 2010). Alternatively, Wang and Hamilton required observers to generate a motor response following the presentation of a manual gesture (i.e., stimulus-response paradigm) (see Roberts, Bennett et al., 2016 for further discussion).

Further evidence that conflicts with the Active-Self account include the lack of modulation shown by low self-monitors. Indeed, low self-monitors are typically concerned with dispositional cues and tend to prime behaviour through the active-self-concept. Thus, they may be described as individuals of *expression*. If the active-self-concept underlies social modulation then it was expected that greater modulation would occur for low self-monitors. This thinking was based on findings of low self-monitors being more likely to guide their primed response behaviour (e.g., select 'lucky' words) according to the observed prime-construct (e.g., observe a prime mask of '7', which is associated with being lucky) (DeMarree et al., 2005; see also Wheeler, DeMarree, & Petty, 2008). However, it appears that the priming effects reported previously in low self-monitors may be different to those pertaining to the mimicry of human actions. In the context of the present study, the low self-monitors

were perhaps less sensitive toward the influence of social context, which led to reduced social modulation.

In summary, we found greater motor contagion in high self-monitors following the presentation of an anti-social prime compared to a pro-social prime. Moreover, high self-monitors appeared to inhibit contagion following a pro-social prime. Therefore, high self-monitors most likely modulated motor contagion through increased sensitivity toward the social context, which suggests social modulation is a result of a primed social incentive within the observer (STORM account; Wang & Hamilton, 2012). As a result, social modulation appears to be underpinned by the *impression* one tries to form given the social context, and not the *expression* of internal states. Indeed, it appears top-down social processes are highly attuned to the precise affects mimicry will have on the observed confederate and subsequent social exchange. Further research is required in order to more precisely examine this proposal. Finally, it is of interest to examine whether these suggestions extend to the observation and copying of non-biological entities such as robots. Following the recent findings of increased neural activity (Chaminade et al., 2010; Gazzola, Rizzolatti, Wicker, & Keysers, 2007) and visuomotor priming (Press et al., 2006) during the observation of actions and emotions of robots, it is possible that human observers could still prime social incentives for the modulation of the copying of non-biological entities.

References

Bekkering, H., Wohlschläger, A., & Gattis, M. (2000). Imitation of gestures in children is goal-directed. *The Quarterly Journal of Experimental Psychology A, 53,* 153-164. doi:10.1080/713755872

Blakemore, S. J., & Frith, C. (2005). The role of motor contagion in the prediction of action. *Neuropsychologia, 43,* 260-267. doi:10.1016/j.neuropsychologia.2004.11.012

Brass, M., Bekkering, H., Wohlschläger, A., & Prinz, W. (2000). Compatibility between observed and executed finger movements: comparing symbolic, spatial and imitative cues. *Brain and Cognition, 44,* 124-143. doi: 10.1006/brcg.2000.1225

Castiello, U. (2003). Understanding other people's actions: intention and attention. *Journal of Experimental Psychology: Human Perception and Performance, 29,* 416-430. doi: 10.1037/0096-1523.29.2.416

Chaminade, T., Zecca, M., Blakemore, S. J., Takanishi, A., Frith, C. D., Micera, S.,… (2010). Brain response to a humanoid robot in areas implicated in the perception of human emotional gestures. *PLoS One, 5,* e11577. doi:10.1371/journal.pone.0011577

Chartrand, T. L. & Bargh, J. A. (1999). The chameleon effect: the perception-behavior link and social interaction. *Journal of Personality and Social Psychology, 76,* 893-910. doi: 10.1037//0022-3514.76.6.893

Chartrand, T. L., & Lakin, J. L. (2013). The antecedents and consequences of human behavioral mimicry. *Annual Review of Psychology, 64,* 285-308. doi:10.1146/annurev-psych-113011-143754

Cheng, C. M., & Chartrand, T. L. (2003). Self-monitoring without awareness: using mimicry as a nonconscious affiliation strategy. *Journal of Personality and Social Psychology, 85,* 1170-1179. doi:10.1037/0022-3514.85.6.1170

Cook, J. & Bird, G. Social attitudes differentially modulate imitation in adolescents and adults. (2011). *Experimental Brain Research, 211,* 601-612. doi: 10.1007/s00221-011-2584-4

Cook, R., Press, C., Dickinson, A., & Heyes, C. (2010). Acquisition of automatic imitation is sensitive to sensorimotor contingency. *Journal of Experimental Psychology: Human Perception and Performance, 36,* 840-852. doi:10.1037/a0019256

DeMarree, K. G., Wheeler, S. C., & Petty, R. E. (2005). Priming a new identity: self-monitoring moderates the effects of nonself primes on self-judgments and behavior. *Journal of Personality and Social Psychology, 89,* 657-671. doi:10.1037/0022-3514.89.5.657

Dijkerman, H. C. & Smit, M. C. (2007). Contagion of grasping observation during prehension, a behavioural study. *Experimental Brain Research, 176,* 387-396. doi: 10.1007/s00221-006-0627-z

Dijksterhuis, A., Spears, R., Postmes, T., Stapel, D., Koomen, W., et al., (1998). Seeing one thing and doing another: Contrast effects in automatic behaviour. *Journal of Personality and Social Psychology, 75,* 862-871. doi: 10.1037//0022-3514.75.4.862

Estow, S., Jamieson, J. P., Yates, J. R. (2007). Self-monitoring and mimicry of positive and negative social behaviors. *Journal of Research in Personality, 41,* 425-433. doi: 10.1016/j.jrp.2006.05.003

Gazzola, V., Rizzolatti, G., Wicker, B., & Keysers, C. (2007). The anthropomorphic brain: the mirror neuron system responds to human and robotic actions. *Neuroimage, 35,* 1674-1684. doi:10.1016/j.neuroimage.2007.02.003

Hardwick, R. M. & Edwards, M. G. (2012). Motor contagion and facilitation arising from observed movement kinematics. *The Quarterly Journal of Experimental Psychology, 65,* 840-847. doi: 10.1080/17470218.2012.672995

Hommel, B., Müsseler, J., Aschersleben, G., & Prinz, W. (2001). The Theory of Event Coding (TEC): A framework for perception and action planning. *Behavioral and Brain Sciences, 24,* 849-878. doi: 10.1017/S0140525X01000103

Kilner, J. M., Paulignan, Y., & Blakemore, S. J. (2003). An contagion effect of observed biological movement on action. *Current Biology, 13,* 522-525. doi: 10.1080/17470910701428190

Lakin, J. L. & Chartrand, T. L. (2003). Using nonconscious behavioural mimicry to create affiliation and rapport. *Psychological Science, 14,* 334-339. doi: 10.1111/1467-9280.14481

Lakin, J. L., Chartrand, T. L., & Arkin, R. M. (2008). I am just too like you: nonconscious mimicry as an automatic behavioural response to social exclusion. *Psychological Science, 19,* 816-822. doi: 10.1111/j.1467-9280.2008.02162.x

Leander, N. P., Chartrand, T. L., & Bargh, J. A. (2012). You Give Me the Chills: Embodied Reactions to Inappropriate Amounts of Behavioral Mimicry. *Psychological Science, 23*, 772-779. doi:10.1177/0956797611434535

Leighton, J., Bird, G., Orsini, C., & Heyes, C. (2010). Social attitudes modulate automatic imitation. *Journal of Experimental Social Psychology, 46,* 905-910. doi: 10.1016/j.jesp.2010.07.001

Mattar, A. A. G. & Gribble, P. L. (2005). Motor learning by observing. *Neuron, 46,* 153-160. doi: 10.1016/j.neuron.2005.02.009

Miles, L. K., Nind, L. K., Henderson, Z., & Macrae, N. (2010). Moving memories: behavioural synchrony and memory for self and others. Journal of Experiment Social Psychology, 46, 457-460. doi: 10.1016/j.jesp.2009.12.006

Over, H. & Carpenter, M. (2009). Priming third-party ostracism increases affiliative imitation in children. *Developmental Science, 12,* F1-F8. doi: 10.1111/j.1467-7687.2008.00820.x

Press, C., Gillmeister, H., & Heyes, C. (2006). Bottom-up, not top-down, modulation of imitation by human and robotic models. *European Journal of Neuroscience, 24,* 2415-2419. doi:10.1111/j.1460-9568.2006.05115.x

Press, C., Gillmeister, H., & Heyes, C. (2007). Sensorimotor experience enhances automatic imitation of robotic action. *Proceedings of the Royal Society B: Biological Sciences, 274,* 2509-2514. doi:10.1098/rspb.2007.0774

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology, 9,* 129-154. doi: 10.1080/713752551

Liepelt, R., Cramon, D. Y., & Brass, M. (2008). What is matched in direct matching? Intention attribution modulates motor priming. *Journal of Experimental Psychology: Human Perception and Performance, 34,* 578-591. doi:10.1037/0096-1523.34.3.578

Press, C., Bird, G., Flach, R., & Heyes, C. (2005). Robotic movement elicits automatic imitation. *Cognitive Brain Research, 25,* 632-640. doi:10.1016/j.cogbrainres.2005.08.020

Press, C., Gillmeister, H., & Heyes, C. (2007). Sensorimotor experience enhances automatic imitation of robotic action. *Proceedings of the Royal Society B Biological Sciences, 274,* 2509-2514. doi:10.1098/rspb.2007.0774

Rizzolatti, G., & Sinigaglia, C. (2010). The functional role of the parieto-frontal mirror circuit: interpretations and misinterpretations. *Nature Reviews Neuroscience, 11,* 264-274. doi:10.1038/nrn2805

Roberts, J. W., Bennett, S. J., & Hayes, S. J. (2016). Top-down social modulation of interpersonal observation-execution. *Psychological Research, 80,* 487-495. doi:10.1007/s00426-015-0666-9

Roberts, J. W., Hayes, S. J., Uji, M., & Bennett, S. J. (2015). Motor contagion: the contribution of trajectory and end-points. *Psychological Research, 79,* 621-629. doi: 10.1007/s00426-014-0589-x

Snyder, M. (1974). Self-monitoring of expressive behavior. *Journal of Personality and Social Psychology, 30,* 526-537. doi: 10.1037/h0037039

Snyder, M. & Gangestad, S. (1986). On the nature of self-monitoring: Matters of assessment, matters of validity. *Journal of Personality and Social Psychology, 51,* 125-139. doi: 10.1037//0022-3514.51.1.125

Sparks, S., Douglas, T., & Kritikos, A. (2016). Verbal social primes alter motor contagion during action observation. *The Quarterly Journal of Experimental Psychology, 69,* 1041-1048. doi 10.1080/17470218.2015.1113304

van Baaren, R. B., Maddux, W. W., Chartrand, T. L., de Bouter, C. & van Knippenberg, A. (2003). It takes two to mimic: behavioural consequences of self-construals. *Journal of Personality and Social Psychology, 84,* 1093-1102. doi: 10.1037/0022-3514.84.5.1093

Wang, Y. & Hamilton, A. F. de C. (2012). Social top-down response modulation (STORM): a model of the control of mimicry in social interaction. Frontiers in Human *Neuroscience, 6,* 153. doi: 10.3389/fnhum.2012.00153

Wang, Y. & Hamilton, A. F. de C. (2013). Understanding the role of „self" in the social priming of mimicry. *PLoS One, 8,* e60249. doi: 10.1371/journal.pone.0060249

Welsh, T. N., Elliott, D., Anson, J. G., Dhillon, V., Weeks, D. J., Lyons, J. L., & Chua, R. (2005). Does Joe influence Fred's action? Inhibition of return across different nervous systems. *Neuroscience Letters, 385,* 99-104. doi:10.1016/j.neulet.2005.05.013

Wheeler, S. C., DeMarree, K. G., & Petty, R. E. (2007). Understanding the role of the self in prime-to-behavior effects: The active-self account. *Personality and Social Psychology Review, 11,* 234-261. doi: 10.1177/1088868307302223

Wheeler, S. C., DeMarree, K. G., & Petty, R. E. (2008). A match made in the laboratory: Persuasion and matches to primed traits and stereotypes. *Journal of Experimental Social Psychology, 44,* 1035-1047. doi:10.1016/j.jesp.2008.03.007

Figure captions

Figure 1. Hypothesized effects for the STORM (top panel) and Active-Self (bottom panel) accounts of social modulation. Notably, the factor of perspective (1^{st}, 3^{rd}) is featured only in the Active-Self account because it upholds no known relevance to the STORM account. Pro-social and anti-social prime conditions are highlighted by *white* and *grey* bars, respectively.

Figure 2. Illustration of the experimental procedure. Participants completed a scrambled-sentence task before undertaking the motor task (or interpersonal observation-execution). The scrambled-sentences featured a pro-social or anti-social prime in the first- or third-person perspective. The motor task featured the observation of a congruent (horizontal) or incongruent (curvilinear) movement. The prime conditions were presented in blocked order and the observed movement stimuli were presented in random order.

Figure 3. Standard deviation within the orthogonal axis of movement as a function of observed movement stimulus (congruent, incongruent) and self-monitoring (high, low). Pro-social and anti-social prime conditions are highlighted by *white* and *grey* bars, respectively. Error bars represent between-subject standard errors.

Footnotes

1. We do not suggest self-monitoring is solely categorised by a nominal distribution of select individuals, but instead operates on a continuous scale rendering some individuals with more/less self-monitoring tendencies (Snyder, 1974; Synder & Gangestad, 1986).

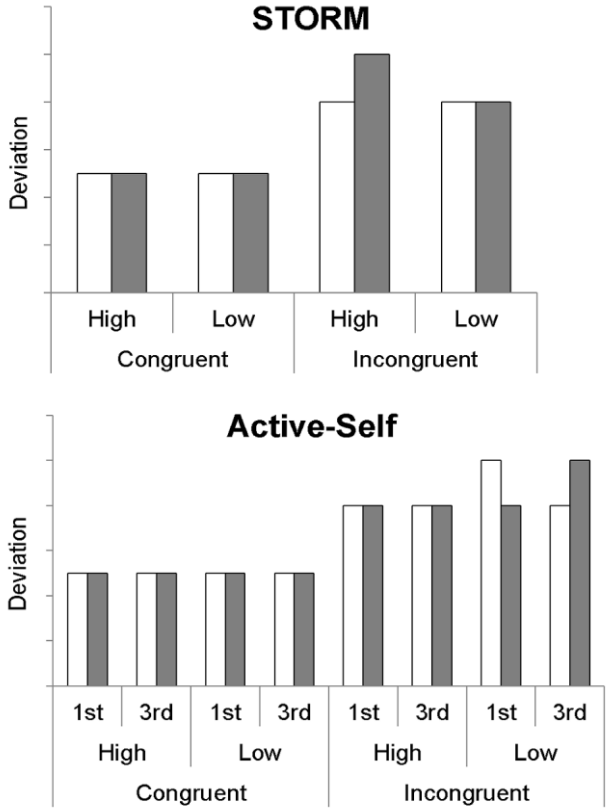
STORM
Deviation
High
Low
High
Low
Congruent
Incongruent
Active-Self
Deviation
1st
3rd
1st
3rd
1st
3rd
1st
3rd
High
Low
High
Low
Congruent
Incongruent

Figure 1

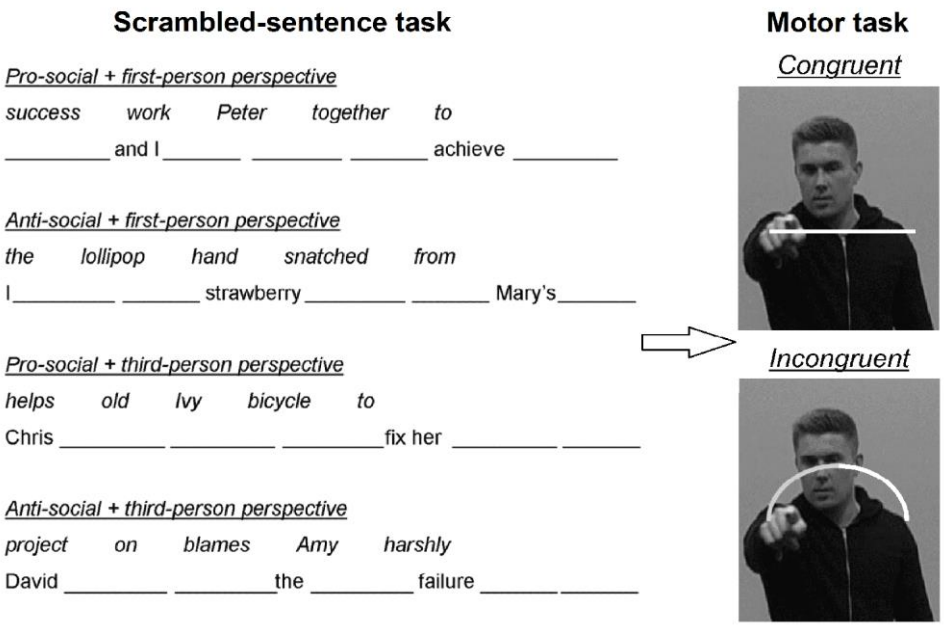
Scrambled-sentence task
Pro-social + first-person perspective
success work Peter together to
_____ and I _____ _____ _____ achieve _____
Anti-social + first-person perspective
the lollipop hand snatched from
I_____ _____ strawberry _____ _____ Mary's_____
Pro-social + third-person perspective
helps old Ivy bicycle to
Chris _____ _____ _____fix her _____ _____
Anti-social + third-person perspective
project on blames Amy harshly
David _____ _____the _____ failure _____ _____
Motor task
Congruent
Incongruent

Figure 2

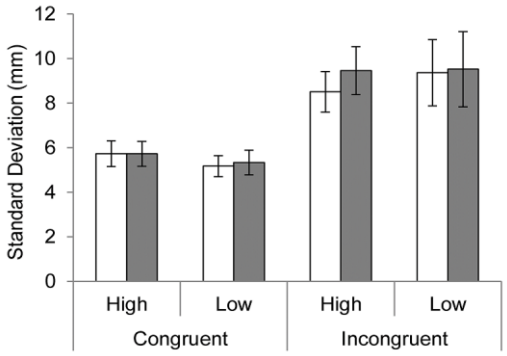
Standard Deviation (mm)
12
10
8
6
4
2
0
High
Low
High
Low
Congruent
Incongruent

Figure 3