Social attitudes modulate automatic imitation

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ABSTRACT

In naturalistic interpersonal settings, mimicry or "automatic imitation" generates liking, affiliation, cooperation and other positive social attitudes. The purpose of this study was to find out whether the relationship between social attitudes and mimicry is bidirectional: Do social attitudes have a direct and specific effect on mimicry? Participants were primed with pro-social, neutral or anti-social words in a scrambled sentence task. They were then tested for mimicry using a stimulus-response compatibility procedure. In this procedure, participants were required to perform a pre-specified movement (e.g. opening their hand) on presentation of a compatible (open) or incompatible (close) hand movement. Reaction time data were collected using electromyography (EMG) and the magnitude of the mimicry/automatic imitation effect was calculated by subtracting reaction times on compatible trials from those on incompatible trials. Pro-social priming produced a larger automatic imitation effect than anti-social priming, indicating that the relationship between mimicry and social attitudes is bidirectional, and that social attitudes have a direct and specific effect on the tendency to imitate behavior without intention or conscious awareness.

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There is evidence that unconscious mimicry[1] promotes smooth and harmonious social interactions and strengthens social relationships (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003). It has been demonstrated that, when people are not aware that their behavior is being copied, being mimicked increases rapport (Chartrand & Bargh, 1999), feelings of closeness (van Baaren, Holland, Karremans, & van Knippenberg, in press), altruistic behavior (van Baaren, Holland, Kawakami, & van Knippenberg, 2004) and trust (Bailenson & Yee, 2005). In a study where half the participants were mimicked by a confederate and half were not, participants who were mimicked reported liking the confederate more than those who were not (Chartrand & Bargh, 1999). In another study, waitresses who were instructed to mimic their customers received bigger tips than those who were instructed not to mimic (van Baaren, Holland, Steenaert, & van Knippenberg, 2003). Thus, a range of studies suggest that unconscious mimicry is linked to increased positive social attitudes.

Although the effects of mimicry on social attitudes have been studied extensively (e.g., Bavelas, Black, Lemery, & Mullett, 1986; Chartrand & Bargh, 1999), only a small number of studies have examined the converse relationship—the impact of social attitudes on mimicry. Some early research suggested that among romantic couples there is a

correlation between the amount of rapport they feel with each other and the amount of mimicking that takes place during their interactions (Bernieri, 1988; see LaFrance, 1979, 1982; LaFrance & Broadbent, 1976 for related work). Furthermore, Heider and Skowronski (submitted for publication) have shown that individuals are more likely to mimic those of their own race, rather than those of a different race. The difference in the degree of mimicry towards own and other races was explained by differences in explicit and implicit racial attitudes.

Two recent studies (Lakin & Chartrand, 2003, see also Lakin, Chartrand & Arkin, 2008; van Baaren, Maddux, Chartrand, De Bouter, & Van Knippenberg, 2003) have directly investigated the effect of social attitudes on mimicry. Lakin and Chartrand (2003) manipulated the extent to which participants aimed to affiliate with an interaction partner and found that an increased desire to affiliate resulted in greater mimicry. Van Baaren and colleagues varied self construal orientation, and found that participants with either a temporarily induced, or chronic, dominant interdependent self construal were more likely to match the behaviors of a confederate than those with an independent self construal (van Baaren, Maddux, et al., 2003).

In previous research on the relationship between social attitudes and mimicry, including that of Lakin and Chartrand (2003) and van Baaren, Holland, et al. (2003), van Baaren, Maddux, et al. (2003), mimicry was measured by scoring matching behavior in naturalistic social interactions. In the majority of these studies, a participant interacted with a confederate who either shook their foot or rubbed their face with above average frequency. The interaction was recorded and subsequently scored. Judges measured the frequency of each action for each participant, yielding a 'mimicry score'. For example, mimicking behavior is foot shaking in the presence of a foot shaking confederate and non-

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[1] Copying of familiar, observed body movements is known as mimicry in the literature on social interaction, and as imitation or automatic imitation in cognitive neuroscience. Here we use mimicry and automatic imitation as synonyms or, as indicated in the text, automatic imitation as a subset of mimicry which is not subject to intentional control.

mimicking behavior is foot shaking in the presence of a face rubbing confederate. In another technique used by van Baaren, Holland, et al. (2003), van Baaren, Maddux, et al. (2003), the confederate manipulated a pen, and judges then scored how much time each participant spent manipulating a similar pen.

The naturalistic approach has many strengths–most notably, its ecological validity–but this approach inevitably leaves unanswered a number of important questions about the relationship between social attitudes and mimicry: First, do social attitudes influence mimicry directly, or by modulating the amount of attention given by the participant (or "observer") to the body movements of the confederate (or "model")? In the latter case, the reported effect of positive social attitudes on mimicry would be merely a secondary consequence of the effect of social attitudes on attention to interaction partners. In other words, social attitudes may influence the probability that a person will process or attend to a model's body movements, but not the probability that attended body movements will be copied. This kind of attentional hypothesis has been advanced, but not tested, by others. For example, van Baaren, Holland, et al. (2003), van Baaren, Maddux, et al. (2003) suggested that an independent self-construal leads to increased attention towards the self and reduced attention towards others. The authors proposed that in this case "fewer mannerisms of others would be observed, decreasing the likelihood of mimicry" (p1100, van Baaren, Holland, et al., 2003, van Baaren, Maddux, et al., 2003). Additionally, Lakin and Chartrand (2003), argued that, "the desire to affiliate may cause people to pay more attention to what occurs in their social environments (i.e. they perceive more), which would result in a stronger relationship between perception and behavior."

A second question concerns the specificity of the effects of social attitudes on mimicry: Do social attitudes influence the frequency with which observers copy the specific *movements* of a model (e.g. face *rubbing*, foot *shaking*), or merely the frequency with which they move the same *effector*, or part the body, as the model (e.g. *hand/face* movements, *foot* movements). For example, an observer with a foot shaking model may be more likely to perform a variety of foot movements - not just foot shaking - than an observer with a face-rubbing model, and this difference may be greater when the observers have more positive social attitudes. Non-specific effects of this kind are known in the motor control literature as 'effector priming' (Bach & Tipper, 2007; Berger & Hadley, 1975; Gillmeister, Catmur, Liepelt, Brass, & Heyes, 2008). Similarly, rather than promoting copying of the specific movements of the model, positive social attitudes may enhance attention to, and thereby contact with, the object of the model's movements. For example, when a model is observed manipulating a pen (van Baaren, Holland, et al., 2003, van Baaren, Maddux, et al., 2003), increased attention to the pen may result in an increase in frequency of all pen-directed behavior, not just the manipulative movements used by the model. Effects of this kind are known in the comparative animal literature as 'stimulus enhancement' (Spence, 1937).

A third outstanding question concerns the automaticity of the mimicry that is modulated by social attitudes. Previous studies have shown that this kind of mimicry is automatic in the sense that, in post-test interviews, participants do not report awareness of the model's focal behavior (e.g. foot shaking, face rubbing), an intention to mimic, or awareness that they mimicked the model's behavior in the course of the experiment (e.g. Chartrand & Bargh, 1999). However, previous research in this area has not examined whether the mimicry that can be modulated by social attitudes is automatic in another important sense; whether it can occur even when it is counter to the participant's intention. "Automatic imitation" is the term used in the motor control literature for mimicry–copying of body movements–that occurs even when it conflicts with the demands of the participant's current task, and is therefore understood to be un- or counter-intentional.

Rather than assessing mimicry in a naturalistic setting, the present study used a stimulus-response compatibility, reaction time paradigm (e.g. Bird, Leighton, Press, & Heyes, 2007; Bird et al., 2007; Brass,

Bekkering, & Prinz, 2001; Brass, Bekkering, Wohlschlager, & Prinz, 2000; Leighton & Heyes, in press) to address these questions about the directness and specificity of the relationship between social attitudes and mimicry, and to find out whether the kind of mimicry that is modulated by social attitudes occurs when counter to intention, i.e. whether it is 'automatic imitation'.

Each participant completed two tasks: first a social attitude priming task, and then an automatic imitation task. In the priming task, participants formed sentences from sets of words that included pro-social, neutral or anti-social terms (three groups). In each trial of the automatic imitation task, participants were required to perform a pre-specified hand movement (open or close) as soon as they saw a hand on a computer screen begin to move. They were required to make the same movement response (open or close) in every trial within a block of trials. The nature of the hand movement stimulus (open or close) varied randomly over trials. Therefore, the hand movement stimulus was either the same as the pre-specified response (compatible trials, e.g. open stimulus and open response), or the hand movement stimulus was the opposite of the pre-specified response (incompatible trials, e.g. close stimulus and open response). Previous studies using this paradigm, which did not manipulate social attitudes, have found an automatic imitation effect: participants make their hand movement responses faster in compatible than in incompatible trials (Heyes, Bird, Johnson, & Haggard, 2005; Leighton & Heyes, in press; Press, Bird, Walsh, & Heyes, 2008; Stürmer, Aschersleben, & Prinz, 2000). Therefore, the automatic imitation task provides an index of mimicry: any difference in response time between compatible and incompatible trials is attributable to the relationship (matching or non-matching) between the observed and executed actions.

If social attitudes have a direct and specific effect on mimicry, and if the mimicry that they modulate is not intentional, then participants primed with pro-social words should show a larger automatic imitation effect than those primed with anti-social words, and the neutral group should show an intermediate automatic imitation effect.

Materials and methods

Participants

Thirty six consenting healthy participants with an average age of 31.3 years, 20 male, were recruited from the University College London's subject database and paid a small honorarium for their participation. All were right-handed, had normal or correct-to-normal vision, and were proficient in the English language. Participants were randomly assigned to one of three groups and were all naïve with respect to the purpose of the experiment. The experiment was performed with local ethical committee approval and in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Stimuli

In both the priming and automatic imitation tasks, stimuli were presented on a computer screen (60 Hz, 400 mm, 96DPI). Viewing was unrestrained at a distance of approximately 600 mm. In the priming task, words were presented in color on a grey background. Each trial showed five words arranged horizontally across the screen. Words were presented in Arial, font size 24 and the color of the words varied randomly over trials. Words were either presented in green, blue, red or yellow.

Three versions of the scrambled-sentence test were constructed: One was intended to prime the pro-social attitude, another the anti-social attitude and a third was intended to prime neither attitude (the neutral priming condition). For both the pro-social and the anti-social priming versions, 12 of the 24 trials contained an adjective or verb semantically related to the trait in question. For the pro-social priming version, the critical priming words were: *affiliate, friend, cooperate,*

together, ally, associate, join, team, agree common, jointly, assist (e.g., "my she is friend toast"). For the anti-social priming version, the 12 critical stimuli were *rebel, independent, individual, disagreeable, single, apart, enemy, alone, selfish, obstruct, obstinate, distrust* (e.g., "they our enemy are fluster"). In both the pro-social and anti-social versions, the 12 prime words were accompanied by 12 neutral words. The neutral prime version consisted of the 24 neutral words from the two other prime versions. The neutral words were *raisin, pillow, bench, buy, bill, bus, back, cat, travel, pigeon, sunshine, tree, car, radio, form, bread, open, soldier, telephone, water land, glass, opera, foot* (e.g., "is raisin this hard too").

Prior to the experiment a pilot study was carried out to verify the semantic relationship between the target words and the attitudes we intended to prime. A separate sample of 10 participants was asked to rate each word in terms of how social they considered it to be on a 5 point ordered category scale (1 = *very anti-social*, 5 = *very pro-social*). A Friedman test indicated significant differences between pro-social, neutral and anti-social words in terms of how 'social' they were judged to be ($p = .001$). The results of this pilot study are shown in Fig. 2A. They confirmed that the stimulus words were strongly related to the attitudes that they were intended to prime.

In the automatic imitation task, all stimuli were presented in color on a black background. Each imperative stimulus was a photographic image of a human hand in an opened or a closed posture. It was preceded by a warning stimulus representing a neutral posture of the same hand type in the same naturalistic style. The stimuli are shown in Fig. 1. Details of the size (width and height), luminance and surface area of the stimuli are given in Table 1.

Procedure

Each participant was tested individually and gave informed consent prior to the start of the experiment. At the end of the experiment, each subject was fully debriefed about the purpose of the experiment.

Upon arrival at the laboratory, the participant was led into the testing room and asked to sit at the desk facing the computer. The experimenter sat next to the participant and explained that the participant was to complete two short, unrelated experiments: the first examining the effect of color on the ability to form comprehensible sentences, and the second to provide information for the University College London Psychology department database. The experimenter provided written instructions for each task, and explained the procedure verbally for further clarification. For the first study, participants were told that they would see five words arranged horizontally across the screen and that they should use four of out of the five words to make a complete sentence. The subjects were told to select the words by clicking on each one with the computer mouse. They were told that once they had clicked on the fourth and final word in their created sentence, a new screen would appear with five different words in a different color than in the previous trial.

After subjects had completed the priming task they were given the instructions for the second part of the experiment. In this experiment
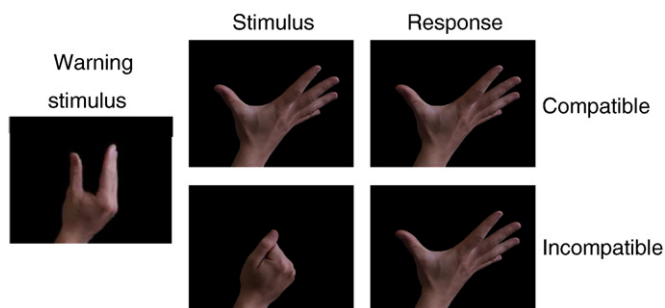
Table 1
Visual angle, luminance and surface area values for each posture in the stimulus format. Relative luminance was measured on a scale between 0 (completely black) and 255 (completely white).

Posture	Width degrees of visual angle	Height degrees of visual angle	Relative luminance	Surface area cm²
Opened	20.2	16.7	75	154
Neutral	10.7	16.4	75	109
Closed	10.6	13.6	68	94

the participant's right forearm lay in a horizontal position. It was supported by an armrest which allowed the hand to move freely. The fingers moved upwards during open responses and downwards when closing. Stimulus movements were presented in the lateral plane (left right), and therefore response movements were orthogonal to stimulus postures. This feature of the design allows automatic imitation to be isolated from spatial compatibility. After each response, participants returned their hand to a neutral starting position. In each block, participants were instructed to make a pre-specified response (open or close), as soon as possible after the movement stimulus appeared. Participants were instructed to refrain from moving their hand in catch trials, when the imperative stimulus was not presented.

All trials began with presentation of the warning stimulus. In stimulus trials, this was replaced 800–1500 ms later by the movement stimulus, which was of 480 ms duration. The stimulus onset asynchrony varied randomly between 800 and 1500 ms. After the movement stimulus, a blank screen was presented (3000 ms) before the next trial. In catch trials, the warning stimulus remained on the screen for 1980 ms. Each block presented, in random order, 15 trials in which the hand opened, 15 trials in which the hand closed, and 6 catch trials. Thus, in each block, there were 15 trials in which the response and stimulus movements matched ('compatible trials') and 15 in which the stimulus and response movements did not match ('incompatible trials').

Participants completed two blocks; in one block, subjects opened their hand in response to the imperative stimulus and in the second block, they closed their hand in response to the imperative stimulus. Whether the participants opened their hand or closed their hand in the first block was determined prior to the start of the experiment and was counterbalanced across subjects.

Before testing commenced in each block, participants completed ten practice trials with the response, and to the stimuli, to be used in that block.

Following the second block of trials, participants were asked to complete a debriefing questionnaire designed to ascertain whether participants has guessed the purpose of the experiment (see Appendix 1).

Participants in the pro-social and neutral priming groups were then paid and informed that they were free to leave. For ethical reasons, members of the anti-social priming group were given the pro-social priming task before leaving.

RT data recording and analysis

For both open and close responses, response onset was measured by recording the electromyogram (EMG) from the first dorsal interosseus (FDI) muscle using disposable Ag/AgCl surface electrodes. Signals were amplified, high-pass filtered at 20 Hz, mains-hum filtered at 50 Hz and digitised at 2.5 kHz. They were rectified and smoothed using a dual-pass Butterworth filter, with a cut-off frequency of 50 Hz. Signals were not low-pass filtered. To define a baseline, EMG activity was registered for 100 ms when the participant was not moving at the beginning of each trial. A window of 20 ms was then shifted progressively over the raw data in 1 ms steps. Response onset was defined by the beginning of the first 20 ms window after the imperative stimulus in which the standard deviation for that window, and for the following 20 ms epoch, was

Fig. 1. Examples of two of the four trial types used in the automatic imitation task. Response movements were made in the horizontal plane and stimulus postures were presented in the vertical plane. Therefore, the direction of response movements was orthogonal to that of stimulus movements.

greater than 2.75 times the standard deviation of the baseline. This criterion was chosen during initial calibration of the equipment as the most effective in discriminating false positives from misses. Whether the criterion correctly defined movement onset in the present experiment was verified by sight for every trial performed by each participant. Stimulus onset marked the beginning, and EMG onset marked the end, of the response time (RT) interval. Errors were recorded manually.

Results

To remove trials in which participants did not attend to the movement stimulus, incorrect responses (e.g. hand open when close was required, 0.05%) were excluded from the analysis, as were all RTs smaller than 100 ms and greater than 1000 ms (0.05%). On each trial, the stimulus movement was either the same as (compatible) or different from (incompatible) the pre-specified response. The RT data for each of these trial types are given in Table 2. The magnitude of the automatic imitation effect for each participant was calculated by subtracting RT in compatible trials from RT in incompatible trials. Fig. 2B shows the automatic imitation effects for each priming group.

Automatic imitation effects were examined using ANOVA in which group (pro-social, neutral anti-social) was the between subjects factor, and mean RT was the covariate. A main effect of priming group was found ($F_{(2,34)} = 4.042$, $p < 0.027$). Contrasts revealed that the pro-social group showed a significantly greater automatic imitation effect than the anti-social group ($F_{(1,22)} = 6.148$, $p < 0.022$), and there was a significant linear trend across the three groups ($p < 0.008$), indicating that the pro-social group showed the largest automatic imitation effect, followed by the neutral group, with the anti-social group showing the smallest automatic imitation effect. No other contrasts approached significance.

Examination of the questionnaire data indicated that no participant correctly guessed the purpose of either the first or second experiment. Furthermore, no participant correctly identified a link between the studies, or a theme among the words presented in the priming task. Therefore, we can conclude that no participant was aware of the type of priming they had received or that the purpose of the study was to examine automatic imitation and its relationship with social attitudes.

Discussion

Two previous studies, using naturalistic methodology, suggested that social attitudes have an influence on unconscious mimicry (Lakin & Chartrand, 2003; van Baaren, Holland, et al., 2003, van Baaren, Maddux, et al., 2003). The purpose of the present study was to find out whether this influence is direct and specific, and to establish whether the imitative behavior that is modulated by social attitudes occurs, not only without conscious awareness, but also when counter to intention. We used, for the first time in research on mimicry and social attitudes, a stimulus-response compatibility paradigm. We found that people who had been primed with words promoting pro-social attitudes (e.g. *affiliate, friend, cooperate, together*) showed a greater automatic imitation effect that people who had been primed with words promoting anti-social attitudes (e.g. *rebel, independent, individual, disagreeable*). That is, in a task where, for example, participants were required to open their hand in response to hand open
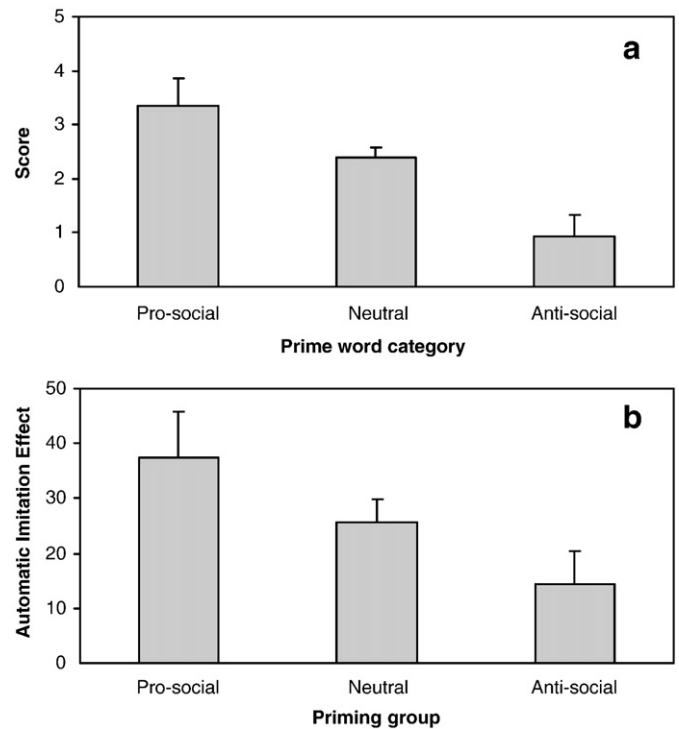

Fig. 2. (A) Mean scores for each group of prime words on a 5 point scale (1 = very anti-social, 5 = very pro-social). (B) Mean magnitude of the automatic imitation effect (RT in incompatible trials minus RT in compatible trials) for each of the three priming groups. Vertical bars indicate standard error of the mean.

and hand close stimuli, the identity of the observed movement (open or close) had a stronger influence on speed of responding in the pro-social than in the anti-social group.

It is very unlikely that the relationship we found between social attitudes and mimicry was indirect, i.e. that it was a secondary consequence of the effects of social attitudes on attention to body movement stimuli. This is because, in contrast with the tasks used to assess mimicry in naturalistic settings, our compatibility task *required* attention to the movement stimuli; any trials in which participants did not attend were detected by checking for incorrect responses, and for abnormally long or short reaction times, and these trials were excluded from the analysis.

Automatic imitation under constant attention has been demonstrated in a number of studies (e.g. Berger & Hadley, 1975; Dimberg, 1982), including previous studies utilizing stimulus-response compatibility paradigms (e.g. Bird et al., 2007; Brass et al., 2000; Brass et al., 2001; Leighton & Heyes, in press; Press et al., 2008). However, the demonstration of an increased tendency to mimic following pro-social priming using the stimulus-response paradigm, which requires constant attention to be performed correctly, has implications for the interpretation of the results of the Lakin and Chartrand (2003) and the van Baaren, Holland, et al. (2003), van Baaren, Maddux, et al. (2003) studies. As previously discussed, the results of these studies can be interpreted in at least two ways; (1) that social priming increased the degree of attention paid to the participants' interaction partner which caused an increase in mimicry ("indirect route"), or (2) that social priming increased the degree to which mimicry was observed with no change in attentional focus i.e. that the same degree of action perception produces more mimicry behavior following social priming ("direct route"). The current results rule out an attentional explanation of the priming effect seen in this study, and make it likely that the results obtained by Lakin and Chartrand and Van Baaren et al were due to the direct effects of priming on mimicry.

Furthermore, the effect that we observed could not have been non-specific: due to a tendency to move the same body part (effector

Table 2
Mean RTs and standard error, in milliseconds (ms), for participants in each of the three priming groups on compatible and incompatible trials.

Prime group	Compatible trials	Incompatible trials
Pro-social	313.3 (25.3)	351.3 (31.2)
Neutral	289.5 (16.7)	315.1 (17.5)
Non-social	371.0 (30.4)	385.3 (28.9)

priming), or to touch the same object (stimulus enhancement), as the model, rather than to produce the same body movements as the model (mimicry or imitation). The effect cannot be attributed to effector priming because we used two movements (open and close) of the same effector (the right hand), and it cannot have been due to stimulus enhancement because neither of the movements involved manipulation of an object.

Thus, our results indicate that there is a direct and specific causal relationship between social attitudes and mimicry. In addition, they suggest that the mimicry that can be modulated by social attitudes is, not only unconscious, but also beyond intentional control. In the compatibility paradigm used in this study, the identity of the movement made by the stimulus hand (open or close) was task-irrelevant; the movement of the stimulus hand was just a 'go signal' telling participants *when* to respond, but not *which* response to make. Rather, the participant's task, and therefore their intention, was to make the pre-specified response as quickly as possible in every trial. Therefore, slower responding in incompatible than in compatible trials (the index of mimicry or automatic imitation) was counter-intentional.

This point highlights an important difference between the design of the present study and that of van Baaren, Holland, et al. (2003), van Baaren, Maddux, et al. (2003), and Lakin and Chartrand (2003). In all three studies mimicry was automatic. Participants were unaware that their actions were affected by the actions they observed, and they had no intention to mimic. However, in the Van Baaren et al and Lakin and Chartrand studies observation of action caused participants to *initiate* imitative actions and therefore mimic their interaction partner. In the present study, the tendency to imitate following pro-social priming affected the *performance* of a pre-specified action, such that imitative actions were performed faster than non-imitative actions. The effect of the pro-social priming was therefore to increase the effect of an automatic tendency to mimic, rather than to increase the frequency of overt mimicry behavior. These findings allow one to conclude that pro-social priming may influence not only action selection, but also the on-line control of action.

When performing the compatibility task, participants observed movements of an isolated human hand on a computer screen; they did not interact live with a whole person. Therefore, the findings suggest that social attitudes can modulate mimicry of body movements, not only in the rich context of naturalistic social interactions, but also in a minimal social context. This, in turn, implies that the cognitive mechanisms mediating this kind of mimicry are relatively low-level; that they do not depend on complex processing of a wide range of social stimuli.

The associative sequence learning model (Brass & Heyes, 2005; Heyes, 2001, 2003; Heyes & Ray, 2000) suggests that mimicry is mediated by low-level mechanisms in which activation of a sensory representation of a body movement (e.g. by visual attention to that movement) necessarily results in activation of a motor representation of the same movement (and thereby an impulse to perform the movement), provided that the sensory and motor representations have become linked through previous, correlated experience of observing and executing the movement. If this is correct, then in principle social attitudes could modulate mimicry via an attentional route - by influencing the probability that sensory representations of body movement will be activated - or via an inhibitory route - by influencing the degree to which activation of motor representations by associated sensory representations is suppressed to prevent overt performance of the represented movement.

A range of social attitudes has been shown to affect the degree to which mimicry behavior is observed. These include: a desire to affiliate (Lakin & Chartrand, 2003), an interdependent self (van Baaren, Holland, et al., 2003, van Baaren, Maddux, et al., 2003), a drive for social inclusion (Lakin et al., 2008), and now pro-sociality. Despite subtle differences, each social attitude refers to an increase in sociability. Across multiple studies then, an increase in sociability has been associated with increased imitation.

The results of the present study suggest that social attitudes do not affect mimicry via an attentional route (see above). Further experiments will be necessary to establish whether, for example, positive social attitudes lead to the release of inhibition of mimicking motor output, and, if so, whether the inhibitory mechanisms that are subject to such modulation are task-general (Logan, 1994) or specifically involved in regulating social responses (Brass & Spengler, 2008). The statistical analysis of the present experiment provided some evidence that the neutral priming group showed an automatic imitation effect smaller than that of the pro-social priming group, but larger than that of the anti-social priming group. This raises the possibility, also requiring further investigation, that pro-social attitudes lead to a decrease, and anti-social attitudes to an increase, in inhibition of mimicking responses relative to baseline levels of inhibition.

The results of studies investigating the effect of mood on cognition are consistent with the hypothesis that social attitudes modulate mimicry via their effects on inhibitory mechanisms. Positive mood, which is associated with prosocial attitudes, can lead to poor performance on Stroop inhibition tasks (Phillips, Bull, Adams, & Fraser, 2002), increased distractibility (Dreisbach & Goschke, 2004), and impairment of the ability to distinguish self from others (Stroessner, Mackie, & Michalsen, 2005). Brass and colleagues have argued that susceptibility and resistance to automatic imitation depend on inhibitory mechanisms that allow one's own actions to be distinguished from the observed actions of others (Brass, Derfuss, & von Cramon, 2005). Therefore, it is possible that positive social attitudes promote, and negative social attitudes reduce, automatic imitation via mood-mediated effects on inhibitory mechanisms.

The results of this study also have implications with respect to the social function of mimicry. Previous research has shown that being mimicked promotes pro-social behavior (e.g. Chartrand & Bargh, 1999), and consequently it has been suggested that mimicry is a non-conscious tool that individuals use instinctively to facilitate social interactions with others (Chartrand & Jeffers, 2003; Cheng & Chartrand, 2003; Lakin & Chartrand, 2003). By confirming that the relationship is bidirectional, and that the effect of pro-social attitudes on mimicry is both direct and specific, the present study suggests that mimicry and social attitudes are part of a positive feedback loop in which pro-social attitudes generate mimicry, and mimicry further increases positive social attitudes. This relationship may be "instinctive" or a product of social learning; for example, humans may have an innate tendency to mimic more when they are in an affiliative frame of mind, or we may learn through interaction with others that it is under these circumstances that mimicry tends to be most rewarding. In either case, it is likely that positive, bidirectional feedback between social attitudes and mimicry, not only facilitates day-to-day social interactions, but has played an important role in the evolution of human cooperation (Sterelny, 2003).

Appendix 1. Debriefing Questionnaire

What do you think the purpose of the first experiment was?
What do you think the purpose of the second experiment was?
What do you think the first experiment was trying to study?
What do you think the first experiment was trying to study?
Did you think that any of the tasks were related in any way? If yes, in what way?

Did anything you did on one task affect anything you did in another task? If yes, then how did it affect you?

When you were arranging the words, did you notice anything unusual about the words?

Did you notice a pattern or theme to the words?

Did you have a particular goal or strategy when arranging the words?

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