Contingency and Contiguity of Imitative Behaviour affect Social Affiliation

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Acknowledgements

We would like to thank Gregory Born for creating the video clip set. The work of RP was supported by a grant from the German Research Council (Deutsche Forschungsgemeinschaft; DFG; grant number PF 853/2-1

Data and analysis scripts for this article can be retrieved from the Open Science Framework: https://osf.io/ht4p7/?view_only=5ad13fc30df14c1cb7c9a2a298a276f2 .

Abstract

Actions of others automatically prime similar responses in an agent's behavioural repertoire. As a consequence, perceived or anticipated imitation facilitates own action control and, at the same time, imitation boosts social affiliation and rapport with others. It has previously been suggested that basic mechanisms of associative learning can account for behavioural effects of imitation whereas a possible role of associative learning for affiliative processes is poorly understood at present. Therefore, this study examined whether contingency and contiguity, the principles of associative learning, affect also the social effects of imitation. Two experiments yielded evidence in favour of this hypothesis by showing more social affiliation in conditions with high contingency (as compared to low contingency) and in conditions of high contiguity (compared to low contiguity).

Key words: imitation; behavioural mimicry; associative learning; contingency; contiguity

Introduction

Imitation or mimicry refers to situations in which one agent copies the actions of another agent (c.f. Heyes, 2013; Prinz, 2002). By definition, copying an action requires some form of similarity between perceived and executed movements or the underlying goals. Indeed, it has been suggested that the matching of topographical features between model and imitator action is the defining aspect of imitation (Heyes, 2016). This becomes most apparent in situations in which an agent imitates automatically as we will outline in the following.

Automatic imitation

Imitation often occurs spontaneously and automatically, without explicit intention to imitate (Heyes, 2011). For instance, observing the gesture of another person makes people more likely to adopt this gesture (e.g., Chartrand & Bargh, 1999; Meltzoff & Moore, 1977). In a typical setup to investigate automatic imitation in the laboratory, Brass, Bekkering, Wohlschläger and Prinz (2000) asked participants to lift either their index or middle-finger in response to a cue. Simultaneously with the cue, participants saw the video of a hand on the screen lifting either the same or a different finger than what was indicated by the cue. Reponses were faster when the observed irrelevant movement was congruent with the to-be performed movement, compared to a situation in which the observed and the to-be performed movement were incongruent (see also Brass, Bekkering & Prinz, 2001; Catmur, 2015; for other effector systems than fingers, see Bach & Tipper, 2007; Dignath & Eder, 2013; Kilner, Hamilton, & Blakemore, 2007; Leighton, Bird, Orsini, & Heyes, 2010).

Interestingly, this motoric impact of imitative tendencies is observed not only when copying someone else’s movements, but also when one´s own movements are about to being copied by someone else. In a study by Pfister, Dignath, Hommel and Kunde (2013), participants acted as an action model and their responses were predictably followed by either the same or a different response of another agent, the imitator. Model responses were faster when the same movement followed compared a different movement, suggesting that the anticipation of being imitated facilitated response initiation (for related findings, see Genschow & Brass, 2015; Müller, 2016). Perceived as well as anticipated actions of others thus have the power to automatically prime similar responses in the own behavioural repertoire.

Associative learning frameworks for imitation

But what exactly is a similar response? In order to account for the motor impact of imitation, some theoretical accounts assume that similarity is the result of a conceptual matching between two events (Jansson, Wilson, Williams, & Mon-Williams, 2007). For instance, according to the supra-modal mapping account, matching between observed and own proprioceptive information takes place via higher-level, supramodal representations (Meltzoff & Moore, 1997). In contrast, other theoretical views assume that a conceptual match between similar responses is not necessary for imitation. Instead, imitation effects are described as a result from associative learning mechanisms (Heyes, 2001). This hypothesis has been directly tested by training studies. For instance, Heyes and colleagues (Heyes, Bird, Johnson, & Haggard, 2005) compared the effect of different training interventions on imitation in a task similar to the one employed by Brass et al. (2000). On this task, they compared the performance of a counter-imitative training group (hand opening had to be responded to by hand closing and vice-versa) to a imitative training group (hand opening had to be responded to by hand opening), and found imitation effects to be absent in the incompatible training group whereas there were prominent imitation effects in the compatible training group. This study suggests that imitation is the result of an experience-based link between sensory input and motor output (see also Catmur et al., 2008; Catmur, Walsh, & Heyes, 2009; Gillmeister, Catmur, Liepelt, Brass, & Heyes, 2008).

Social effects of imitation

The motor effects of imitation integrate seamlessly in theoretical frameworks that build on associative learning. However, there is more to imitation than the described motor effects, because imitation also comes with social consequences. For instance, in a seminal study by Chartrand and Bargh (1999), imitating increased social affiliation towards the other person. Interestingly, this effect has been observed both when someone is imitating another person and when they are being imitated by another person (cf. Chartrand & Bargh, 1999). Subsequent studies generalized this finding and observed that imitation increased prosocial behaviour (Van Baaren, Holland, Kawakami, & Van Knippenberg, 2004), promotes monetary generosity in customer relations (Van Baaren, Holland, Steenaert, & van Knippenberg, 2003), reduces stereotyping (Inzlicht, Gutsell, & Legault, 2012), and increases attractiveness (Adank, Stewart, Connell, & Wood, 2013) and empathy (De Coster, Verschuere, Goubert, Tsakiris, & Brass, 2013).

It is currently unclear, however, whether the social consequences of imitation are mediated by associative learning similar to the motor effects of imitation. In a recent review, Hale and Hamilton (2016) outlined three possible accounts of why mimicry affects liking: the self-other overlap account, the contingency account and the similarity account. Of these the self-other overlap account is both the most cognitively demanding and least developed. On this account the social effects of mimicry are produced by the fact that mimicry leads to a greater perceived similarity between self and other and this in turn leads to an increased sense of affiliation. However, the mechanism by which this similarity comparison occurs and is transferred to a feeling of social affiliation is generally left unspecified.

By contrast both the contingency and similarity accounts take a broadly associative approach which suggests that the positive social effects of mimicry are largely due to the reward activation during successful learning and prediction of the other's actions which is aided by the close association between those actions and their own. They differ primarily in whether they consider mere contingency or the specific similarity of effector between one's own actions and the other's is the property which is associatively learnt. However, there have been only relatively few attempts to directly test these different accounts of the social consequences of imitation meaning that the exact mechanisms remain highly speculative (Hale and Hamilton, 2016).

Does contingency/contiguity affect the social consequences of imitation?

The present research investigated whether basic learning principles that affect the association between two events have an influence on the social effects of imitation. Traditionally, the strength of an associative link is conceived as a function of predictability – i.e., *contingency* – and temporal proximity – i.e., *contiguity* – between two events (Pearce & Hall, 1980; Rescorla & Wagner, 1972). Indeed, there is recent evidence suggesting that the same principles of associative learning also moderate motor effects of imitation. For instance, Cook, Press, Dickinson and Heyes (2010) showed that counter-imitative training is only effective if the to-be executed movement is predictably followed by a specific observed movement, but not if this relation is unpredictable.

Particularly relevant to the question of how social effects of imitation might be mediated by contingency is a recent study by Catmur and Heyes (2013). This study provided first evidence that predictability between executed and observed movements contributes on the social effects of being imitated. Participants in this study freely chose to execute either a foot or a hand movement which triggered the presentation of a foot movement, a hand movement or no movement. Importantly, the authors orthogonally manipulated the similarity of effector between executed and observed movements (e.g., foot > foot vs. foot > hand) and the contingency between executed and observed movements (e.g., predictably “foot > hand” vs. sometimes “foot > hand”, sometimes “foot > no movement”). Participants who´s movements were consistently followed by the movement of either effector reported after the experiment that they had enjoyed the task more and that they felt closer to their best friend than participants who´s movements were only inconsistently followed by another movement (because in 50 % of the trials the participants’ movement caused no movement on the screen). Interestingly, similarity between effectors had no effect on these measures.

Although this study provides initial evidence that contingency may be a crucial factor for the social effects of imitation, several factors do not allow for drawing definite conclusions at present. First, conditions with high contingency (hand movements always followed by hand movements) also came with high contiguity because the imitation movement appeared in close temporal proximity to the model movement. Conditions with low contingency (hand movements being followed by no movement on the screen at times) obviously also came with low contiguity because model movement and the next following movement were temporally separated by a larger interval as well as an additional motor action of the model. Second, previous research assessed the effect of imitation on social affiliation with respect to the other person involved in imitation, i.e., participants judged the same person that previously interacted with them. Thus, social consequences of imitation were mostly specific to the source of facilitation or interference during imitation. In contrast, the ratings of social affiliation used by Catmur and Heyes (2013) were relatively unspecific, because participants never interacted with a real or virtual other during the imitation treatment but rather these ratings targeted more indirect measures such as task enjoyment and closeness to one’s best friend. Third, and in our view most importantly, the order of events in the study of Catmur and Heyes (2013) allows for an alternative explanation not related to imitation per se. Participants performed movements that were followed (or not) by the observation of a movement on the screen (execution ▶ observation). Consequently, participants might have conceived the observed movement as a consequence of their own action and the observed influence of contingency might relate to the processing of action effects in general. Indeed, this procedure closely resembled procedures used for action-effect learning in which participant's voluntary select a response that is consistently followed by a specific effect stimulus (Elsner & Hommel, 2001). From the literature on action-effect learning it is well-known that people prefer consistent mappings between actions and effects over inconsistent mappings (Elsner & Hommel, 2001; Pfister, Kiesel, & Hoffmann, 2011, for converging evidence from animal studies, see Logan, 1965) and they prefer situations that allow production of an (irrelevant) outcome over situations in which actions produce no outcome (Stephens, 1934; Eitam, Kennedy & Higgins, 2013). To conclude, Catmur and Heyes (2013) provided initial evidence that contingency may affect social consequences of imitation, but it remains to be seen whether contingency indeed affects social judgments of the other person involved in imitation when contiguity is controlled for, and whether this impact generalizes even to situations in which the other's action cannot be conceived as an effect of the participant's action.

Less attention has been paid in the literature on the social consequences of imitation to the other key factor in mediating associative learning – contiguity. In fact, we are only aware of one study which has attempted to experimentally test how differing times of imitation affect perceptions of the imitator (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004). This study examined how well participants could detect whether or not they were being imitated and found that detection of imitation was directly correlated with the delay of the imitator with detection significantly reduced for delays of more than one second. Subsequent studies (Bailenson & Yee, 2005; Hasler, Hirschberger, Shani-Sherman, & Friedman, 2014) have used this information to minimise mimicry detection when trying to build affiliation via mimicry, based on findings that greater detection of imitation can lead to aversive rather than affiliative reaction (Bailenson, Yee, Patel, & Beall, 2008). To our knowledge, however, no published study has directly examined the effect of the timing of imitation on social affiliation judgements.

The present research

To summarize, an associative account that aims to explain the social consequences of imitation makes two central predictions: First, predictability of movements, not similarity between movements mediates the social consequences of imitation. And second, principles of associative learning mediate the social consequences of imitation. Now, to find supportive evidence for this account, one could either (i) manipulate predictability and similarity of executed and observed movement orthogonally, to tease apart the respective contribution of both factors or (ii) one could manipulate factors that facilitate (or impair) associative learning to see whether this increases (or decrease) social affiliation. In the present research, we took the second approach and hypothesized that key factors known to affect associative learning – contingency and contiguity – also affect the evaluation of the other person observed during imitation. Two experiments tested these assumptions by manipulating contingency (Experiment 1) and contiguity (Experiment 2) between the participants' executed movements and the observed movements of another agent and probed for an effect of these manipulations on social affiliation judgements.

In addition, we draw on previous findings that the motor and social consequences of imitation emerge both, for situations in which participants' actions follow the actions of another person (we will refer to this order of events [observation ▶ execution] as the *imitating condition*) and for situations in which participants' actions are followed by another person (we will refer to this order of events [execution ▶ observation] as the *being-imitating condition*). Comparing imitated and being-imitated conditions allows us to draw conclusions about how general associative learning principles influence social affiliation. While action-effect learning provides a reasonable explanation for the being-imitated condition (see the above critique of Catmur & Heyes, 2013), action-effect learning does not apply to the imitating condition so that this condition provides a clear-cut test that cannot be related to action-effect learning.

Experiment 1

We hypothesized that, if social affiliation during imitation is the result of contingency between executed and observed movements, reducing (or increasing) the contingency between executed and observed movements should reduce (or increase) the social evaluation of the interaction partner. Experiment 1 tested this hypothesis with three different contingency conditions. Participants performed either vertical or horizontal movements with a slide controller while they observed a video of another person controlling the same apparatus (see Figure 1). Participants performed short blocks of trials with one specific person in the video (the model), before they had to evaluate how much they liked the model. In one third of these blocks, the model´s movements matched the movements of the participant in 100% of the trials (e.g., vertical > vertical) (*high contingency* condition), while in another third of these blocks, the model´s movements matched the movements of the participant in 75% of the trials whereas they did not match in the remaining 25% (e.g., mismatch: vertical > horizontal) (*medium contingency* condition), and in the remaining blocks, the model´s movements matched the movements of the participant in 50% of the trials (*low contingency* condition).

More positive social evaluations of those models associated with more contingent imitative responses are taken as an index of associatively modulated social preferences induced by imitation. To control that this effect is not due to action-effect learning, but is indeed the result of imitative behaviour, we tested half of the participants in a condition in which they imitated the model (*imitating* condition) and the remaining half of participants in a condition in which they were imitated by the model (*being-imitated* condition).

Method

Participants

Fifty-six adults (3 left-handed, 39 women, 19–63 years, *M* = 27.62 years) were recruited via a participant pool management system and received 7 € for participation. Participants were randomly assigned to one of the two imitation conditions. Data of one participant was removed from the analyses due to unusual high error rates (*M* >= 31% across conditions; > 3 SDs from the group mean of 5.9%).

Apparatus and Stimuli

Participants moved a slide controller with their left and right hand either in a horizontal or vertical direction. Movement data was collected by photoelectric barriers at each end of the movement paths. Playing card symbols (clubs and spade; 72 px x 72 px) served as imperative cues, indicating whether the participant was required to make a vertical or horizontal movement, and were presented in the center of a 19'' screen with a screen resolution of 1024 x 768. Cue-movement assignment was counterbalanced across participants. A sinusoidal tone of 60 dB with a frequency of 800 Hz was presented via headphones as a Go-Signal. Movie clips of twenty-seven different actors (8 male) were presented. These movie clips were selected from a set of forty movie clips that were pre-rated by thirty-five neutral raters on a 0-9 rating scale according to attractiveness (selected sample *M* = 3.68, *SD* = 0.45) and affiliation (selected sample *M* = 3.27, *SD* = 0.41) of the target person shown. In each clip, a person was depicted sitting on a chair and moving the same slide controller as the participants (see https://osf.io/t4qme/?view_only=f8ca2cc0202441818d836ea16ee7b62e for an example). The upper torso of the target person was visible in a slight high-angle front shot. To reduce variance due to specific personal characteristics of the target, each person wore a dark-coloured leisure suit and a dark baseball cap on the head to occlude the target's face (cf. Topolinski & Sparenberg, 2012)

Procedure

Trials started with an exclamation mark being presented for 500ms, followed by the imperative cue that was presented for 1000ms. The cue informed the participants about the correct movement for the upcoming trials, though participants were instructed to wait for an acoustic Go-signal to commence their movement.

The following events differed between the *imitating condition* and the *being-imitated* condition. In the *imitating* condition, the screen was blanked for 500ms, and then a video showed a model performing a vertical or horizontal movement for approximately 10s. Finally, the Go-signal appeared and prompted participants to execute the pre-specified movement as fast as possible. In the *being-imitated* condition, the Go-signal was played directly after the imperative cue. After participants had finished their movement, the screen was blanked for 500ms, followed by the presentation of the video. At the end of each trial, a message informed participants to move the slider back to the home position and the program paused until both slide controllers were returned before starting the next trial. A warning message appeared for 2s when the participants performed the wrong movement or when they performed the movement too fast (initiation time, IT, < 100ms), too slowly (IT > 1000ms) or asymmetrically (one controller reached the target position while the other had not left the home location).

Participants first performed 10 training trials of vertical and horizontal movements to become familiar with the task. No videos were shown during these training trials. In the actual experiment, there were 27 blocks[1] of 16 trials each, with a new model presented in each block of trials. Models were assigned to three different sets and the assignment of sets to the contingency conditions was counterbalanced across participants. There were blocks in which the model and the participant performed always the same movement (*high contingency* condition), blocks in which the model and the participant performed the same movement in 75% of the trials (*medium contingency* condition) and blocks in which the model and the participant performed same and different movements equally often (*low contingency* condition). Order of blocks with different contingency conditions was randomized. At the end each block, participants had to evaluate how much they liked the person in the video ("How much did you like the person in the previous video from 1 (not at all) to 9 (very much)?". Participants indicated their rating with their right hand on an external number pad. At the end of the experiment, participants went through a funnel debriefing that probed there awareness of the contingency manipulation. The complete experimental session lasted approximately one hour.

Results

For the social affiliation ratings, we expected ratings to increase monotonically with increasing contingency in both imitation conditions. We tested this hypothesis with a mixed analysis of variance (ANOVA) with the within-factor *contingency* (high, medium and low) and the between-subject factor *imitation condition* (imitating vs. being-imitated).

Furthermore, we performed exploratory analyses of participants' performance data, that is initiation times (IT), movement times (MT) and error rates with the same mixed ANOVA. Please note that we denoted these analyses as exploratory and

[1] Due to an error when naming and saving the video files, the video of one of the twenty-seven models showed only vertical movements in all conditions. Data from this block was excluded from the analysis.

present performance data here only for completeness. Two-tailed *t*-tests were used for follow-up comparison (Bonferroni adjusted alpha levels of .0083 per test (.05/6) were used to correct for multiple comparisons where appropriate). For IT and MT analysis, error trials and trials that followed an error were eliminated. For the error data, only trials that followed an error were eliminated. In the ANOVAs, all p-values are Greenhouse-Geisser corrected.

Social Affiliation Judgements. Our main interest was the question whether different levels of contingency affected the social evaluation of the model (Figure 2, upper panels). A significant main effect of *contingency* indicated that this was indeed the case, $F(2, 106) = 20.26$, $p < .001$, $\eta_p^2 = .277$. Participants evaluated models in the *high contingency* condition as more positive ($M = 5.23$, $SE = 0.23$) than in the *medium contingency* condition ($M = 4.59$, $SE = 0.17$), $t(54) = 4.99$, $p < .001$, and they evaluated models in the *medium contingency* condition as more positive than in the *low contingency* condition, ($M = 4.36$, $SE = 0.16$), $t(54) = 2.37$, $p = .021$.

Descriptively, mean ratings suggested that participants preferred models when they were imitated by them ($M = 5.05$, $SE = 0.25$) over a situation in which they imitated the movements of the models ($M = 4.41$, $SE = 0.24$), but this effect did not reach the conventional level of significance, $F(1, 53) = 3.45$, $p = .069$, $\eta_p^2 = .061$. The interaction between *imitation condition* and *contingency* was not significant, $F<1$.

Exploratory analyses of performance data[2]. The upper panel of Table 1 shows the means and standard deviation in each condition. Overall, participants were slower when they were being imitated compared to the group of participants who imitated the model, but this difference was not significant, $F(1, 53) = 2.66$, $p = .11$, $\eta_p^2 = .014$. Furthermore, *contingency* did not yield a main effect for ITs, $F<1$, but there was a significant interaction between *imitation condition* and *contingency*, $F(2, 106) = 3.49$, *p*

[2] Please note, that the design of this study was not intended to test for automatic imitation effects in performance data.

= .038, η_p^2 = .062. Descriptively, participants in the *being-imitated* condition (but not in the *imitating* condition) showed faster ITs with higher contingency, although both follow-up ANOVAs were not significant (largest p < .10).

A similar pattern emerged for MTs. Participants were slower when they were imitated by a model, *as* indicated by a main effect of *imitation condition,* $F(2, 53)$ = 11.63, p = .001, η_p^2 = .18. Contingency did not modulate MTs, F<1. Descriptively, MTs mirrored the ITs, but the interaction between *imitation condition* and *contingency* did not reach significance, $F(2, 106)$ = 2.34, p = .104, η_p^2 = .042.

Analysis of error rates showed a tendency that participants made more errors when they were imitated by the model (*M* = 6.6%, *SE* = 0.7%) compared to when they imitated the model themselves (*M* = 4.8%, *SE* = 0.7%), but this effect did not reach the conventional level of significance, $F(1, 53)$ = 3.64, p = .062, η_p^2 = .064. Furthermore, error rates differed for the three *contingency* conditions, $F(2, 106)$ = 3.52, p = .033, η_p^2 = .062, with lowest error rates for the *high contingency* condition (5.8%), more errors for the *medium contingency* condition (5.9%) and most errors for the *low contingency* condition (6.1%; all follow-up comparisons p> .5).

Discussion

Experiment 1 tested the hypothesis that social affiliation during imitation is a function of the contingency between executed and observed movements. Therefore, Experiment 1 manipulated the contingency between executed and observed movements and subsequently assessed how participants evaluated their affiliation towards the observed interaction partner. Results were clear-cut: Participants reported more positive social evaluations of those models associated with highly contingent imitative responses compared to a medium-contingency baseline, and they reported less positive social evaluations of those models associated with less contingent imitative responses. This was true for both, the *imitating* condition and the *being-imitated* condition.

Experiment 2

Experiment 2 complemented the approach of Experiment 1 by targeting the role of contiguity as a relevant factor for social affiliation during imitation. We hypothesized that if a social evaluation of another person is the result of the contiguity between executed and observed movements, reducing (or increasing) the temporal delay between executed and observed movements should increase (or reduce) the social evaluation of the interaction partner during imitation.

Experiment 2 tested this hypothesis with three different contiguity conditions. The experimental procedure was identical to Experiment 1, with the exception that the contingency between executed and observed movements was fixed for all conditions, but we manipulated the temporal interval between executed and observed movements. In a third of the trial blocks, the model´s movements followed/preceded the movements of the participant by 3000ms (*low contiguity* condition), while in another third of the trial blocks, the model´s movements followed/preceded the movements of the participant by 800ms (*medium contiguity* condition). In the remaining third of the blocks, the model´s movements followed/preceded the movements of the participant with no additional delay (*high contiguity* condition). More precisely, the participant was required to respond immediately after the video of the model terminated (*imitating* condition) or the video started immediately after the participant had finished his or her movement (*being-imitated* condition).

Similar to Experiment 1, we expected that, if social consequences of behavioural imitation are modulated by associative learning, participants should prefer models who perform movements in close temporal proximity to own movement over models who perform movements with less temporal proximity.

Method

Participants

Fifty-three adults (9 left-handed, 37 women, 19–59 years, *M* = 28.17 years) were recruited via a participant pool management system and received 7 € for participation. Participants were randomly assigned to one of the two imitation conditions. One participant's data was removed from analyses due to unusual high error rates (*M* >= 31%; > 3 SDs of the group mean of 7.6%).

Procedure

Experiment 2 was identical to Experiment 1 except for the following changes:

Participants worked through 27 blocks with 12 trials each. Ten out of these trials were congruent, two were incongruent (16.67%). The wrongly recorded video clip which was excluded from the analysis in Experiment 1 was replaced by a new (and correct) video clip from the video data-set.

For the *imitating* group, the delay between the end of the models action and the imperative cue affording the participant's responses was manipulated and for the *being-imitated* group, the delay between participant's responses and the beginning of the models action was manipulated. There were blocks with a delay of 0ms (*high contiguity* condition), 800ms (*medium contiguity* condition) and 3000ms delay (*low contiguity* condition). Due to a programming error, no correct debriefing questionnaires were administered.

Results

As in Exp.1, we expected social affiliation ratings to increase monotonically with increasing contiguity in both imitation conditions. To test this hypothesis, a mixed ANOVA with the within-subject factor *contiguity* (0ms delay, 800ms delay, 3000ms delay) and the between-subject factor *imitation condition* (imitating, being-Imitated) was performed. In addition, exploratory analysis of the performance data with an identical ANOVA is also reported. Follow-up *t*-tests were conducted using Bonferroni adjusted alpha levels of .0083 per test (.05/6).

Social Affiliation Judgements. As in Experiment 1, our main focus was whether different levels of contiguity affected the social evaluation of the model (Figure 2, lower panels). This prediction was confirmed by a significant main effect of *contiguity*, $F(2, 102) = 8.59$, $p < .001$, $\eta_p^2 = .144$. Participants preferred models in the *high contiguity* condition ($M = 5.04$, $SE = 0.21$) over models in the *medium contiguity* condition ($M = 4.82$, $SE = 0.19$), $t(52) = 2.11$, $p = .040$. Furthermore, participants preferred models in the *medium contiguity* condition over models in the *low contiguity* condition, ($M = 4.47$, $SE = 0.20$), $t(52) = 2.63$, $p = .011$. No other effects reached significance, *Fs* <1.

Exploratory Analyses of performance data. Data selection and outlier correction of performance data (ITs, MTs and error rates) was identical to Experiment 1. Table 1 shows the means and standard deviation in each condition. There was a main effect of *imitation condition*, $F(1, 53) = 6.34$, $p = .015$, $\eta_p^2 = .111$. Participants were slower in the *being-imitated* condition ($M = 528$ ms, $SE = 24$ ms) compared to the *imitating* condition ($M = 445$ ms, $SE = 23$ ms). Furthermore, there was a significant main effect of *contiguity,* $F(2, 102) = 12.59$, $p < .001$, $\eta_p^2 = .198$, with faster ITs in the *high contiguity* condition ($M = 465$ ms, $SE = 26$ ms) than in the *medium contiguity* condition ($M = 490$ ms, $SE = 16$ ms) and slowest in the *low contiguity* condition ($M = 504$ ms, $SE = 17$ ms). The main effects were further qualified by an interaction between *imitation condition* and *contiguity*, $F(2, 102) = 7.55$, $p = .002$, $\eta_p^2 = .192$. Post-hoc analyses showed that for participants in the *being-imitated* group, ITs increased descriptively with longer delays form the *high contiguity* condition ($M = 502$ ms, $SE = 25$ ms), to the *medium contiguity* condition ($M = 519$ ms, $SE = 23$ ms), although this difference was not significant, $t(25) = 1.58$, $p = .127$, and from the *medium contiguity* condition to the *low contiguity* condition ($M = 563$ ms, $SE = 25$ ms), $t(25) = 4.81$, $p < .001$. This is in line with research on temporal action-effect learning, showing that participant's retrieve temporal delays that follow the response and this retrieval processes prolongs response initiation (cf. Dignath, Pfister, Kiesel, Eder & Kunde, 2014). However, for the *imitating* group, ITs increased descriptively from the *high contiguity* condition (M = 428 ms, SE = 27 ms), to the *medium contiguity* condition (M = 461 ms, SE = 23 ms), $t(26) = 2.65$, $p = .013$, but decreased again for the *low contiguity* condition (M = 445 ms, SE = 22 ms), $t(26) = 2.26$, $p = .032$. Note that this pattern is not very surprising, given that participants in the *imitating* group could use the 3000ms delay to prepare their response.

Analysis of the MTs revealed only a descriptive trend for *imitation condition*, $F(1, 51) = 3.67$, $p = .061$, $\eta_p^2 = .067$. Participants were slower when they were imitated by a model (M = 507 ms, SE = 26 ms) compared to when they imitated a model (M = 435 ms, SE = 26 ms). All other ps > .1.

Error rates showed a marginally significant main effect of *contiguity,* $F(2, 102) = 2.61$, $p < .085$, $\eta_p^2 = .049$, with fewer errors in the *high contiguity* condition (M = 6.7%, SE = .07%) than in the *medium contiguity* condition (M = 7.3%, SE = .07%) and most errors in the *low contiguity* condition (M = 8.0%, SE = .09%; ps >.2 for all follow-up comparisons), all other ps > .25.

Discussion

In Experiment 2, mostly imitative actions of a virtual co-actor preceded/followed the actions of the participant with different temporal delays. Results revealed that the temporal proximity between executed and observed movements of a model affected participant's evaluation of the model. Participants reported increased social affiliation toward those models who acted in close temporal proximity to their own actions. Thus similar to contingency in Experiment 1, contiguity moderated the social effects of imitation.

General Discussion

The present research investigated whether associative learning can account for the social consequences of imitation. Two experiments tested whether contingency and contiguity, factors known to govern associative learning, also affect the evaluation of the other person observed during imitation. Results clearly confirmed this prediction. Both, the contingency of same/different movements between executed and observed movements, and the temporal delay between executed and observed movements modulated the ratings for social affiliation. Participants preferred interaction partners who performed predictable and immediate responses over those who performed unpredictable and delayed movements. Furthermore, contingency and contiguity modulated social affiliation both for the being-imitated group and for the imitating group. This shows that the social consequences of imitation cannot be reduced to action-effect learning and the positive feeling of causing events in the environment (Eitam, Kennedy & Higgins, 2013), but are more likely to reflect general associative learning processes.

Possible alternative explanations

Analysis of the error rates revealed that low contingency also caused more errors. A possible alternative explanation is that participants devaluated models that were associated with higher error rates, because errors are intrinsically negative (Hajcak & Foti, 2008). To check whether judgements of affiliation were due to explicit error feedback, we reran the ANOVA on affiliation judgements, but included only blocks of trials without any errors. Thus, for these blocks, participants could not use explicit error feedback as a basis for their judgement. For Experiment 1, this analysis left a sample of 49 participants with 13 judgements on average (*SD* = 5.04), and for Experiment 2 this analysis left a sample of 49 participants with 14 judgements on average (*SD* = 4.71). In Experiment 1, the main effect of *contingency* remained significant, $F(2, 94) = 13.05$, $p < .001$, $\eta_p^2 = .217$ (all other p´s > .29), and, likewise, in Experiment 2 the main effect of *contiguity* remained significant, $F(2, 94) = 6.18$, $p = .007$, $\eta_p^2 = .116$ (all other *p*s > .23), replicating the results of the main analysis. Thus, we can rule out that explicit error feedback can account for the effect of contingency/contiguity on social affiliation judgements.

Research on the social consequences of imitation stressed that imitation often occurs unconsciously (Chartrand & Bargh, 1999; see Chartrand & Lakin, 2013, for an overview). Typically, in this line of research imitation occurs while participants interact with a confederate and awareness of experimental manipulations is assessed by debriefing procedures that probe participant's knowledge about the experimental condition after the experiment. To control for demand effects in the present experiment we analysed the debriefing questionnaires[3]. In Experiment 1, *N* = 18 participants were identified as aware of the experimental manipulation (although these self-reports should be treated with caution, see Oppenheimer, Meyvis, & Davidenko, 2009). Repeating the main analysis on the subset of *N* = 37 participants who were unaware of the contingency manipulation revealed identical results, with a main effect of *contingency*, $F(2, 70) = 8.01$, $p = .004$, $\eta_p^2 = .186$, all other *p*s > .1. Unfortunately, for Experiment 2 no correct debriefing questionnaires were administered, allowing no conclusive answer how demand effects influenced the rating for contiguity manipulations. Although it is thus possible that demand effects might have influenced the results of Experiment 2, previous research showed that participants who became aware of an imitation manipulation exhibited an ironic effect and devaluated agents

[3] Two raters coded the answers of the participants. Participants were identified as being aware of the experimental manipulation when they affirmed at least one of two questions (question 1: "Did the movement of the person in the video influence your judgement of the other person?"; question 2: Did the frequency of similar or dissimilar movements have an influence on your judgement about the other person?").

who imitated them (Bailenson, Yee, Patel & Beall, 2008; for a review, see Hale & Hamilton, 2016).

Associative learning and social affiliation

The present research is in line with associative learning theories of motor imitation (Brass & Heyes, 2005; Heyes, 2001) by showing that contingency and contiguity, the principles of associative learning, modulate social affiliation judgements. Consequently, the results support and extend associative accounts of mimicry (Hale & Hamilton, 2016) to the temporal domain, highlighting temporal proximity as a key factor for social consequences of imitation (cf. Bailenson, Beall, Loomis, Blascovich, & Turk, 2004). At the same time, it is less clear how the self-other overlap account could accommodate these findings. While some authors advanced an explanation of self-other distinction in terms of learned action-effect predictions (Spengler, von Cramon & Brass, 2009), a view compatible with associative processes, this view is not shared by other theories (e.g. Aron & Aron, 1986). Finally, the present research cannot disentangle the similarity and the contingency account, because highly contingent conditions were also highly similar conditions in Experiment 1. Indeed there is currently no consensus in the literature how contingency and similarity contribute to the social effects of imitation. While some studies reported evidence that contingency, but not similarity increase pro-social judgments (Catmur & Heyes, 2013), others reported the opposite (Kulesza, Szypowska, Jarman, & Dolinski, 2014; see also Sparenberg et al., 2012). Although the present research cannot differentiate between these two accounts, it provides clear evidence that associative learning factors (in this case: temporal contiguity) modulate social affiliation even when the degree of similarity is kept constant.

A critical question for future research is to detail the processes that explain how associative learning affects social affiliation. Two accounts appear tenable. First, manipulating contingency or contiguity could have affected processing dynamics which are intimately linked to phasic affect (c.f. Winkielman & Cacioppo, 2001). For instance, research on processing fluency has shown that predictable stimuli are evaluated more favourably than unpredictable stimuli (e.g., Zajonc, 1968) and that stimuli that appear in closer temporal proximity are judged as more favourable than stimuli that are presented after some delay (e.g., Topolinski & Reber, 2010). Furthermore, these effects have been reported both for perceptual tasks (e.g. Reber, Winkielman, & Schwarz, 1998) and motoric tasks (e.g., Hayes, Paul, Beuger, & Tipper, 2008). Thus, in the present experiments high contingency/contiguity conditions might have caused positive affect due to processing dynamics which then could be used as a cue for the social affiliation judgment.

Alternatively, it is possible that high contingency/contiguity conditions fostered learning and participants could retrieve the episode including the previous model more easily for their judgement. Research on metacognitive judgments showed that people sometimes base their evaluations and preferences on heuristics like the ´ease of retrieval´ heuristic (Schwarz, et al., 1991). Thus, according to this view, associative learning affected encoding and subsequent retrieval of models that were to be judged. Clearly, associative principles could also affect social effects of imitation in a more indirect way. For instance, people could use positive affect or ease of retrieval to draw inferences about shared psychological states (e.g. Lakens & Stel, 2011).

Conclusion

The present research provided evidence that social consequences of imitation – affiliation towards another person – are moderated by basic principles of associative learning. This finding links research on automatic motor imitation with research on social effects of imitation and points to the role of basic learning principles as a common framework. This link could be further elaborated by exploring how ecologically more valid mimicry paradigms (e.g., Chartrand & Bargh, 1999) relate to the more closely controlled settings used in studies of automatic imitation (cf. Chartrand & Lakin, 2013). While some studies provided evidence that social precursors (i.e., social attitudes) modulate automatic imitation (Leighton, Bird, Orsini & Heyes, 2009; Cook & Bird, 2011; Roberts, Bennett & Hayes, 2016), the social consequences of automatic imitation require additional attention from empirical studies.

Compliance with Ethical Standards

All author declare that no conflict of interest exists.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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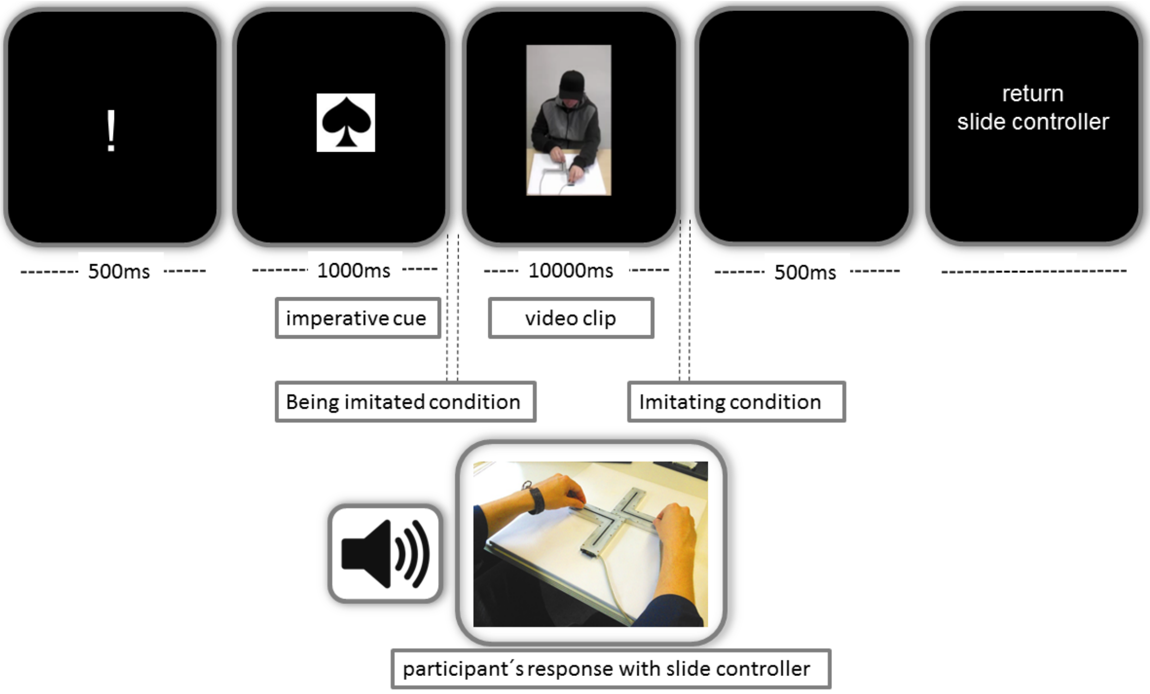
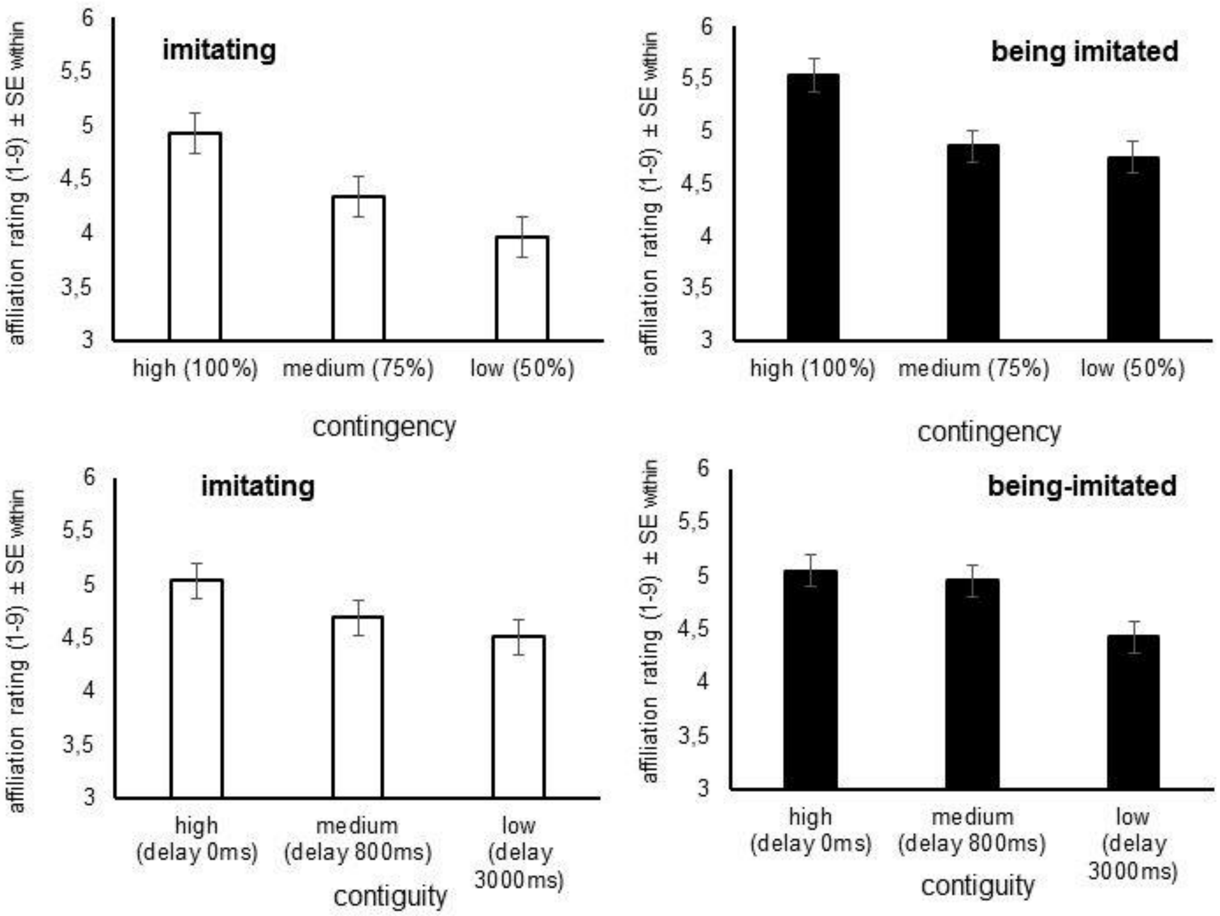


Figure 1. Trial structure in the experimental blocks. Following an unspecific warning signal, the imperative cue indicated whether participants should perform a vertical or horizontal movement with the slide controller, but participants had to wait for an acoustic Go-signal to perform the movement. In the "*being imitated* condition", the Go-signal followed directly after the imperative cue, while in the "*imitating* condition" the go-signal was presented after the video clip. In the video clip, a model performed either vertical or horizontal movement with an identical slide controller. The trial



ended with the request to return the slide controller in the middle position. Participants completed short trial blocks with varying proportions of imitative versus counter-imitative actions of the videotaped model in Experiment 1 to address variations in contingency. Experiment 2 used a fixed contingency throughout but manipulated temporal contiguity between actions of the model and the participant. Importantly, participants were asked to provide social affiliation judgements on a 9-point scale. These social affiliation judgments were then analyzed as a function of contingency and contiguity.

Figure 2. Mean social affiliation ratings of the model for the different contingency conditions of Experiment 1 (upper panels) and for the different contiguity conditions of Experiment 2 (lower panels). Error bars show within-subject standard errors.

Table 1

Means and standard errors for correct initiation times (ms), movement times (in ms) and error rates (in %) in Experiment 1 (upper panel) for each contingency condition and in Experiment 2 (lower panel) for each contiguity condition.

		contingency					
		high (100%)		medium (75%)		low (50%)	
measure	condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
IT (ms)	*being imitated*	521	28	521	28	508	30
	imitating	445	27	451	28	459	29
MT (ms)	*being imitated*	532	23	538	22	528	23
	imitating	423	22	424	22	427	22
error (%)	*being imitated*	7.2	1.0	7.9	1.0	9.2	1.3
	imitating	6.2	1.0	6.7	1.0	6.7	1.3

		contiguity

		high (delay 0ms)		medium (delay 800ms)		low (delay 3000ms)	
measure	condition	*M*	*SD*	*M*	*SD*	*M*	*SD*
IT (ms)	*being imitated*	502	26	519	23	563	24
	imitating	428	26	461	23	446	23
MT (ms)	*being imitated*	508	27	506	27	505	26
	imitating	425	27	445	26	437	25
error (%)	*being imitated*	5.8	0.7	6.9	0.9	7.1	0.7
	imitating	4.4	0.7	4.8	0.9	5.1	0.7