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It Takes Two to Imitate: Anticipation and Imitation in Social Interaction

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Abstract

Imitation is assumed to serve crucial functions in social interaction, such as empathy and learning, yet these functions apply only to the imitating observer. In the two experiments reported here, we revealed a distinct function of imitation for the action model: Anticipation of being imitated facilitates the production of overt motor actions. Specifically, anticipated motor responses of social counterparts serve as mental cues for the model to retrieve corresponding motor commands to orchestrate his or her own actions.

Keywords

social behavior, social interaction, motor processes

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Humans tend to imitate the actions of their social partners, and such imitative behavior is seen as a hallmark of social interaction (Heyes, 2011). Researchers in biology, neuroscience, and psychology have delineated numerous functions of imitation behavior (Bandura, Ross, & Ross, 1961; Heyes, 2011), its development (Gergely, Bekkering, & Király, 2002; Meltzoff & Moore, 1977), and its neural implementation (Heyes, 2010; Iacoboni et al., 1999). Paradoxically, however, all these studies focused on just one side of this social interaction, that of the imitating observer, whereas the imitated model was considered a passive provider of the action in question.

Yet imitative behavior might have a unique function for the action model as well. Because imitation occurs automatically after one observes model actions (Brass, Bekkering, Wohlschläger, & Prinz, 2000; Chartrand & Bargh, 1999; Dijksterhuis & Bargh, 2001), imitative responses are an immediate and predictable action consequence for the model. In turn, cumulative evidence indicates that anticipation of expected sensory consequences controls voluntary motor actions (Hommel, Müsseler, Aschersleben, & Prinz, 2001; Kunde, 2001; Shin, Proctor, & Capaldi, 2010). Specifically, the anticipation of such consequences automatically activates the motor patterns that normally produce the corresponding behavior (Hommel et al., 2001; Kunde, 2001; Pfister, Kiesel, &

Melcher, 2010). We suggest that imitative behavior—a reliable consequence of one's own actions—fulfills a similar function: It serves as a mental cue for the model to retrieve his or her own body movements.

To demonstrate this function, we had 2 participants, a model and an imitator, sit face to face at a table, and each operated one response button (Fig. 1a). The model viewed a computer screen and reacted as quickly as possible to a color stimulus by pressing a button for either a short or a long time. The second participant responded to the model's action as quickly as possible by either imitating or counterimitating the model action; that is, in the counterimitation condition, the imitator performed a long key press in response to a short key press by the model and a short key press in response to a long key press by the model. The two conditions were implemented in separate blocks of the experiment, and each participant performed in both roles. In keeping with previous findings, we expected the imitator to respond faster in the imitation condition than in the counterimitation condition (Brass et al., 2000; Heyes, 2011; Ondobaka, de

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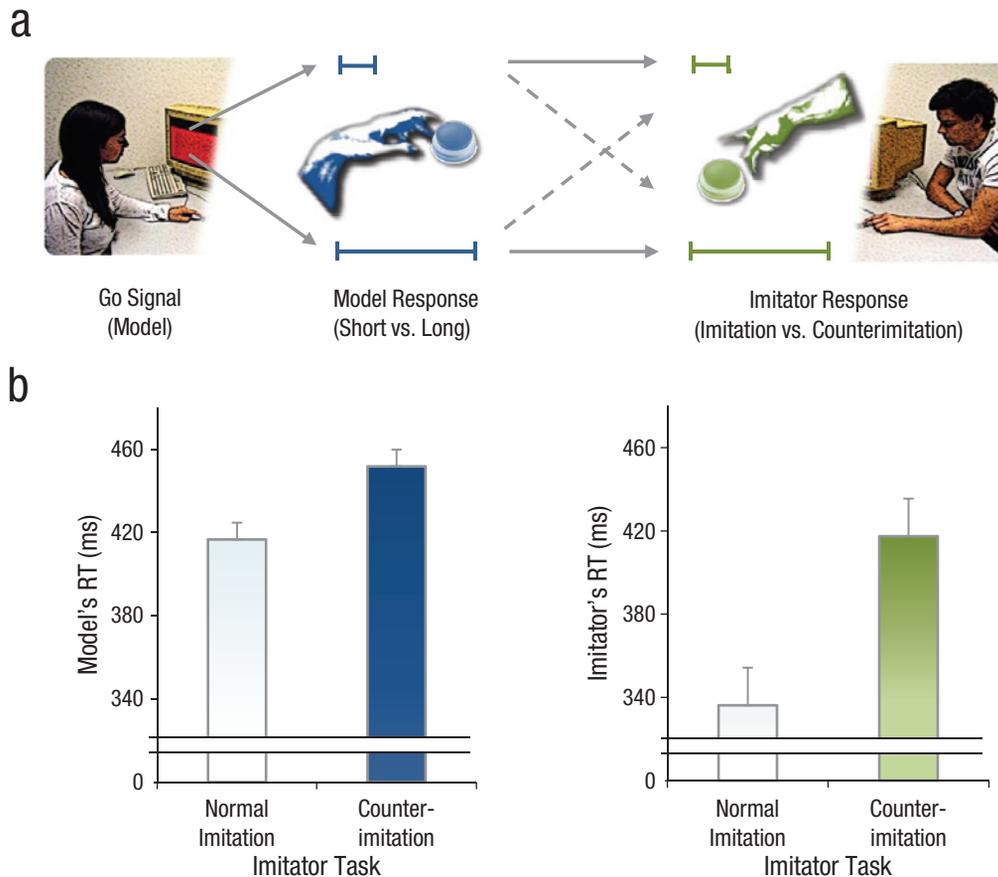


Fig. 1. Design and results of the main experiment. In each trial (a), 2 participants—a model and an imitator—sat face to face at a table. The model watched a monitor and pressed a key for either a short time (1–150 ms) or a long time (200–600 ms), depending on which of two colors appeared on the screen. In separate blocks, the imitator was told to either imitate (solid arrows) or counterimitate (dashed arrows) the model's action. Mean response time (RT; b) for the model (left graph) and the imitator (right graph) is shown as a function of block type. Error bars represent standard errors of paired differences (Pfister & Janczyk, 2013).

Lange, Wiemers, Newman-Norlund, & Bekkering, 2012): Seeing a particular action evokes a tendency to imitate the action, which speeds up actions in the imitation condition but creates response conflict in the counterimitation condition. Crucially, we expected a similar effect in the model: Anticipation of the imitator's response should facilitate action selection if this anticipation matches, and thus primes, the required model action. Conversely, it should impair response selection when the anticipated action mismatches and thus competes with the intended action (Kunde, 2001, 2003). An imitation effect that occurs in the imitator when he or she observes the model's action might consequently occur in the model when he or she merely anticipates the imitator's response.

Method

We tested 24 participants (mean age = 21.0 years; 7 men, 17 women; 1 left-handed) in pairs. During the instruction, we referred to the roles of the participants as “leader”

and “follower” to avoid the terms of “model” and “imitator.” The two participants in each pair sat across from each other, and the model watched a monitor. In each trial, the screen color changed from black to either red or green, prompting the model to press a key for either a short time (1–150 ms) or a long time (200–600 ms). Color-response mapping was counterbalanced across participant pairs. In separate experimental blocks, the imitator either imitated or counterimitated the model action. The screen went blank after the imitator's response, and the next trial started after 1,000 ms.

Each session began with 14 practice trials to acquaint the participants with the concepts of long and short key presses. In these trials, the participants practiced the key presses separately, and the concepts of imitation and counterimitation were introduced afterward. The actual experiment consisted of 20 blocks of 24 trials each, and participants switched roles after 10 blocks. Each half of the experiment consisted of five blocks with normal imitation responses and five blocks with counterimitation

responses, and condition order was counterbalanced across participant pairs.

The first block of each condition was considered practice. For analysis of the models' response time (RT) data, we excluded trials in which the model pressed the key for the wrong amount of time (e.g., the model gave a short key press when a long key press was required; 6.1% of all trials). For the analysis of the imitators' RT data, we excluded trials in which either the model or the imitator made errors (13.2% of all trials). Furthermore, trials were designated as outliers and removed if the corresponding RT deviated by more than 2.5 standard deviations from the participant's condition mean ($< 2.5\%$ for all analyses). To avoid violations of sphericity, we used the multivariate approach to within-subjects analyses of variance (ANOVA) for all reported ANOVA statistics. All pairwise comparisons were performed using paired-samples t tests.

Results

As predicted, models indeed initiated their actions more quickly when those actions were to be imitated rather than counterimitated (Fig. 1b), $t(23) = 4.35$, $p < .001$, $d = 1.26$. In line with prior findings (Brass et al., 2000; Heyes, 2011), this difference was also present for imitators (Fig. 1b), $t(23) = 4.49$, $p < .001$, $d = 1.30$. Follow-up analyses showed that these effects occurred for each type of response and did not result from different speed/accuracy trade-offs (see Fig. S1 in the Supplemental Material available online).

Next, we performed a more detailed distribution analysis of the RT data to ensure that the observed effects were not just driven by a small subset of trials with extremely delayed responses (e.g., in which participants were confused by the incompatible consequences of their actions). To do this, we divided RTs into quintiles from shortest RT to longest RT. This 2 (imitator response: imitation vs. counterimitation) \times 5 (distribution quintile: 1–5) repeated measures ANOVA confirmed that the imitation effects in both roles were reliable across the entire RT distribution (see Fig. S2 in the Supplemental Material). For models, this distribution analysis showed both main effects to be significant ($ps < .001$). A significant interaction between the two factors indicated larger imitation effects for longer RTs (Kunde, 2001), $F(4, 20) = 4.34$, $p = .011$, $\eta_p^2 = .46$, but a reliable difference between imitation and counterimitation responses was present from the first quintile onward. The same was true for imitators (Fig. S2 in the Supplemental Material).

Although superficially similar, the imitation effects in models and observers are conceivably determined by different mental processes: action observation for imitators and action anticipation for models (Paelecke & Kunde,

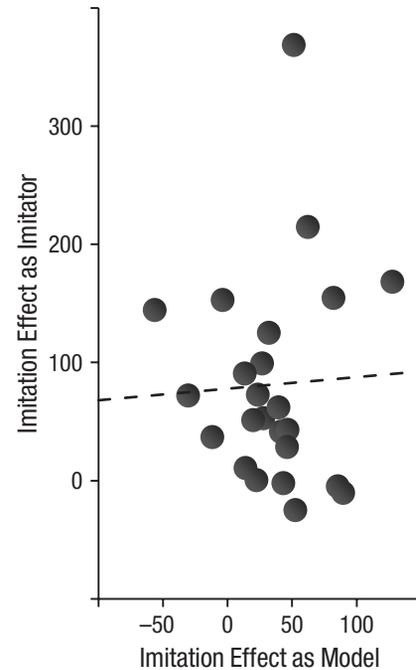


Fig. 2. Scatter plot (with best-fitting regression line) showing the imitation effect when a participant served as imitator as a function of the imitation effect when he or she served as model. The imitation effect was calculated by subtracting the participant's mean response time in the imitation condition from his or her mean response time in the counterimitation condition.

2007). To support this distinction, we correlated the imitation effects of each participant as a model and as an imitator (Fig. 2). Statistical dependency would suggest shared mechanisms, whereas independency would indicate distinct processes. The data clearly support the latter hypothesis, $r = .04$, $t(22) = 0.20$, $p = .840$ (Keller & Koch, 2006; see also Fig. S3 in the Supplemental Material). Conceivably, action priming by action observation (i.e., acting as imitator) is a process distinct from action priming by action anticipation (i.e., acting as model).

Control Experiment

In a second experiment with 16 new participants (mean age = 27.4 years; 3 men, 13 women, all right-handed), we confirmed that the imitation effect in models included both benefits of imitation and costs of counterimitation. We replaced the counterimitation condition with a neutral condition in which the imitator freely chose whether to imitate or to counterimitate in each trial. This rendered the response unpredictable for the model (overall, there were counterimitation responses on 48.3% of trials and imitation responses on 51.7% of trials). Models still reacted faster in the predictable imitation condition than in the neutral condition (424 ms vs. 442 ms, respectively), $t(15) = 2.40$, $p = .030$, $d = 0.60$. A nonsignificant effect in

the same direction was observed in error rates (imitation condition: 8.8%; neutral condition: 11.5%), $t(15) = 0.95$, $p = .356$, $d = 0.24$, which excludes a speed/accuracy trade-off.

Discussion

In the present experiments, we investigated the function of imitative behavior for action models. Model actions were facilitated when they were predictably imitated rather than counterimitated by an observer (Experiment 1). A reliable facilitation effect was also present when comparing imitation with unpredictable responses of the imitator (control experiment). These findings demonstrate that models build a representation of an observer's imitative response before executing their own actions. Thus, motor actions are guided not only by anticipated consequences in the inanimate environment (Hommel et al., 2001; Kunde, 2001; Pfister & Kunde, 2013; Shin et al., 2010) but also by consequences in the social environment (i.e., other people's behavior; see also Kunde, Lozo, & Neumann, 2011).

These results also point toward notable differences between the anticipation of consequences in the inanimate environment as opposed to the social environment. Compared with studies in which the same motor actions (short vs. long key presses) yielded inanimate action consequences (short or long tones; Kunde, 2003), the present imitation effects were considerably larger. This finding is reminiscent of the generally stronger influences of social stimuli compared with inanimate stimuli on motor priming. Such priming effects refer to the facilitation of motor responses that are carried out in response to biologically similar target stimuli (such as the imitator responses in the present imitation condition; see also Brass et al., 2000). These effects have been shown to consist of two components: action priming by spatial compatibility, on the one hand, and action priming by imitative compatibility, on the other hand (Bertenthal, Longo, & Kosobud, 2006; Boyer, Longo, & Bertenthal, 2012; Cooper, Catmur, & Heyes, 2013). It is conceivable that this distinction might also apply to the present anticipatory effect, which is certainly an interesting question for future research.

Questions for future research also relate to consequences of being imitated that go beyond the implications for action control on which we focused here. For instance, being imitated might have a direct impact on the model's mood, similar to the affective consequences of mimicry for both the mimicker and the mimickee (e.g., Chartrand & Bargh, 1999; Stel & Vonk, 2010; van Baaren, Holland, Kawakami, & van Knippenberg, 2004). In contrast to these studies, however, the present experiments explicitly targeted effects of anticipated imitation on action control, and such effects have not yet been studied

in the field of mimicry. Furthermore, on the basis of the described anticipative mechanism, the mere awareness of being imitated, without actually having the corresponding experience, might suffice to produce the effects reported here, at least to a certain extent. The necessary amount of learning experience is certainly an open question.

Anticipated social consequences of one's own actions conceivably also contribute to the "imitative games" between infants and their parents that have been studied in developmental psychology (Agnetta & Rochat, 2004). Even neonates tend to repeat actions that were previously imitated by a human agent. Furthermore, neonates use cycles of reciprocal action initiation and imitation as an early form of communication with their parents (Nagy, 2006; Nagy & Molnar, 2004). This type of communicative action might be mediated by anticipative mechanisms, as demonstrated in the present experiments. Observed changes in other people's behavior thus seem to be readily included in the human motor system and are directly relevant for controlling one's own actions. Moreover, changes in other people's behavior are perceivable cues for a change in their minds, which, according to philosophical approaches, is the very essence of truly communicative action (Grice, 1969). It is therefore important for the understanding of communicative action to study the cognitive processes in acting models in addition to those in imitating observers.

Author Contributions

R. Pfister and D. Dignath developed the study concept. R. Pfister, D. Dignath, and W. Kunde contributed to the study design. Data were collected by R. Pfister and W. Kunde. All authors contributed to writing the manuscript.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Supplemental Material

Additional supporting information may be found at <http://pss.sagepub.com/content/by/supplemental-data>

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