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Imitation and interindividual differences: Belief in free will is not related to automatic imitation

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ABSTRACT

It is well known that individuals have the tendency to automatically imitate each other and that such imitative behavior is fostered by perceiving intentions in others' actions. That is, past research has shown that perceiving an action as internally driven enhances the shared representation of observed and executed actions increasing automatic imitation. An interpersonal factor that increases the perception that a behavior is internally driven is belief in free will. Consequently, we hypothesized that the more individuals believe in free will, the more they automatically imitate others. To test this prediction, we conducted two high-powered (total $N = 642$) and preregistered studies in which we assessed automatic imitation with the imitation-inhibition task. Contrary to our predictions, belief in free will did not correlate with automatic imitation. This finding contributes to current findings challenging the assumption that automatic imitation is modulated by interindividual differences. Further theoretical implications are discussed.

1. Introduction

People automatically imitate a variety of different behaviors, including gestures (Bernieri, 1988; Cracco, Genschow, et al., 2018), simple movements (Brass et al., 2000; Genschow et al., 2012; Genschow & Florack, 2014; Genschow & Schindler, 2016), facial expressions (Dimberg, 1982), and emotions (Dimberg, 1982; Hess & Fischer, 2013). Imitation is considered to be a crucial learning mechanism through which children's personality develops (Bandura, 1962, 1963) and through which children adapt to society (Forman & Kochanska, 2001; Kuczynski et al., 1987). Moreover, imitation serves an important social function in the sense that it bonds humans more strongly together by fostering prosocial behavior (Duffy & Chartrand, 2015; Wang & Hamilton, 2012). For example, imitation enhances helping (van Baaren, Holland, et al., 2004), reciprocal liking (Sparenberg et al., 2012), empathy (Iacoboni, 2009), and the acceptance of other people's perspective (Lamm, Batson, et al., 2007), which is why imitation is often declared to be a social glue (Kavanagh & Winkielman, 2016). A current debate concerns whether interindividual differences can predict the propensity to imitate others (Cracco, Bardi, et al., 2018). In the current research, we investigated the role of belief in free will, which is closely tied to perceptions of intentionality as an important component of automatic imitation.

One of the most often used tasks that allows measuring individuals' automatic tendency to imitate in a very reliable way (Genschow, van Den Bossche, et al., 2017) is the imitation-inhibition task (Brass et al., 2000). In this task, participants respond to two imperative cues with two different finger movements across multiple trials. For example, they are instructed to respond to the number "1" by lifting the index finger and to the number "2" by lifting the middle finger. At the same time, the participants see another person's hand either lifting the same (congruent trial), the other finger (incongruent trial), or no finger at all (neutral trial). Typically, individuals respond more quickly and with fewer errors within congruent trials than within incongruent ones (i.e., congruency effect). The response time to neutral trials lies between the response times to congruent and incongruent trials. The congruency effect can be explained with individuals' automatic tendency to imitate others. That is, in incongruent trials, individuals need to inhibit this tendency, which results in slower reaction times. Likewise, the automatic tendency to imitate is facilitated in congruent trials, which results in faster response onsets (for a meta-analysis, see Cracco, Bardi, et al., 2018). Traditionally, the imitation-inhibition task was used in laboratory settings by measuring movement onsets with custom-built light sensors (e.g., Brass et al., 2000, 2001). More recent research demonstrates the reliability of the task by assessing movement onsets with key releases on computer keyboards in laboratory (Butler et al., 2015; Genschow, van Den

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Bossche, et al., 2017; Longo et al., 2008; Longo & Bertenthal, 2009), as well as online settings (Westfal et al., 2021).

By using the imitation-inhibition task, previous research tested whether automatic imitation is predicted by interindividual differences. For example, Hogeveen and Obhi (2013) found that the degree to which others are automatically imitated varies between narcissistic and non-narcissistic participants. Other researchers found reduced automatic imitation effects in individuals with autistic spectrum disorder as compared to healthy controls (Bird et al., 2007; Cook et al., 2013; Cook & Bird, 2012). Also, empathic traits and the ability to take another person's perspective have been found to correlate with automatic imitation (Cracco et al., 2015). Both of these links have been explained by variation in self-other overlap that should theoretically alter automatic imitation. These findings suggest that certain interindividual characteristics, theorized to relate to processes of automatic imitation, can explain variance in the propensity to imitate others.

However, recent research casts doubt on the link between automatic imitation and several interindividual differences. For example, Butler et al. (2015) could not find support for the idea that broad personality traits related to social behavior (i.e., extraversion and agreeableness) and disorders of social cognition (i.e., autistic-like and schizotypal traits) correlate with automatic imitation. Moreover, the authors could not replicate the findings that narcissistic and empathic traits correlate with automatic imitation. Similar results were obtained by Genschow, van Den Bossche, et al. (2017) who did not find significant correlations between automatic imitation and a variety of stable interpersonal differences including empathy, perspective taking, autism-like traits, and traits related to self-other focus. These findings raise the question of why it is difficult to find links between automatic imitation and interindividual factors. One reason could be that the relation between interindividual differences and automatic imitation is rather small and studies investigating this relation did not have enough power to detect such small effects. Another reason may be that the previously assessed personality factors are not linked closely enough to the mechanisms underlying automatic imitation. Thus, in the present research we aimed at testing, using high-powered samples, whether automatic imitation is predicted by belief in free will—a factor that is closely linked to a key process underlying automatic imitation: perceiving intentionality in others' actions.

1.1. Processes underlying automatic imitation

Automatic imitation is generally explained by a common representation of observed and executed actions. For instance, according to the so-called perception-behavior link (Chartrand et al., 2005; Chartrand & Bargh, 1999) an observed action leads to the same mental representation as the executed action. This shared mental representation, in turn, increases the likelihood of executing the observed action. Likewise, ideomotor theory (Greenwald, 1970; Prinz, 1990, 1997) argues that the visual image of a perceived action is part of its own motor representation. Thus, the observation of a certain action should be sufficient to prime the execution of the same action.

Experiments against the backdrop of ideomotor theory (for an overview, see Prinz et al., 2004) indicates that two principles account for the representation of others: perceptual and intentional induction. Whereas perceptual induction indicates that individuals execute the actions they see, intentional induction means that observers act in order to achieve the anticipated outcome of an action. In line with the latter principle, neuro-physiological investigations indicate that activations in the mirror-neuron system are largely based on inferring intentions in others' actions (Kilner et al., 2007; Lamm, Fischer, et al., 2007). In line with this reasoning, research on anticipated action has suggested that merely inferring another person's intention to initiate an action might be sufficient to trigger the execution of the very same action (Genschow, Bardi, et al., 2018; Genschow & Brass, 2015; Genschow & Groß-Bölting, 2021; Genschow, Klomfar, et al., 2018).

It is important to note that these perceived intentions can be driven by higher-level top-down processes, such as a higher-level beliefs (Bien et al., 2009; Buttelmann et al., 2013; Liepelt et al., 2008; Meltzoff, 1988; Spengler et al., 2010). For example, research in developmental psychology suggests that children are more likely to imitate seemingly meaningless actions if they believe that the actions had been performed intentionally as compared to if they believed that the actions had been performed unintentionally or accidentally (Buttelmann et al., 2013; Meltzoff, 1988). Similarly, adults are more likely to imitate a behavior in which they can recognize a clear intention, as compared to a rather unintentional behavior (Bien et al., 2009).

Research from Liepelt et al. (2008) further supports the crucial role of perceived intentions within the imitation-inhibition task. In several experiments, the researchers implemented two conditions. In the intentional condition, the observed fingers were moved freely by the model. In the unintentional condition the model's fingers were pulled by an apparatus. The researchers found larger congruency effects in the condition in which the fingers were lifted intentionally indicating that perceived intentions are a crucial factor for automatic imitation to occur. Based on these findings, Liepelt et al. argue that perceiving intentions in other persons' movements is based on attributional processes. That is, smaller automatic imitation effects were found “when participants interpreted the observed movement as externally driven than when they attributed the movements as internally generated” (p. 587). In sum, previous research indicates that if observers believe that movements are internally driven (as compared to externally driven), they perceive stronger intentions, which enhance the shared representation of observed and executed action. As a consequence, automatic imitation is increased.

1.2. Belief in free will

A factor that increases internal attributions and perceived intentions in others is belief in free will (Genschow, Rigoni, et al., 2017, 2019). Free will beliefs are stable trait-like metacognitive judgments (Brembs, 2011) about the extent to which individuals intentionally guide their thoughts and actions (Frith, 2012). Individuals who believe in free will, believe that other people are responsible for their actions (Carey & Paulhus, 2013; Nahmias et al., 2008), because they can decide and control their own behavior (Paulhus & Carey, 2011). Thus, not surprisingly, the more people believe in free will, the more they perceive other persons' actions as internally driven (Genschow, Rigoni, et al., 2017, 2019). For instance, in several studies, Genschow, Rigoni, et al. (2017) presented participants with different behaviors and then asked them to which degree they perceive the behaviors as internally or externally driven. The results indicate that individuals generally perceive behaviors as more strongly internally driven than externally driven. Crucially, however, this effect was more strongly pronounced, the more participants believed in free will. In another series of studies, Genschow, Schuler, et al. (2019) presented participants with different video clips. For example, in Study 1 participants watched video clips of football players touching the ball with their hands. It was varied whether the players objectively touched the ball accidentally or intentionally. The researchers found that the more participants believed in free will, the more intentions they perceived in football players touching the ball with their hand irrespective of whether the players actually touched the ball accidentally or intentionally. This indicates that belief in free will correlates with perceived intentions irrespective of how ambiguous the action is.

1.3. Present research

Taken together, the literature on automatic imitation reports mixed results with respect to the question of whether interindividual differences modulate automatic imitation. A reason for the difficulty to find correlations between automatic imitation and interindividual

differences may lay in the fact that most of the previously assessed scales did not tap closely enough into crucial processes underlying automatic imitation. Regarding the processes underlying automatic imitation, it is widely accepted that perceived intentions are a crucial mechanism in the sense that perceiving an action as internally driven enhances the shared representation of observed and executed actions and, thus, automatic imitation (e.g., Liepelt et al., 2008). The literature on free will beliefs indicates that belief in free will increases the perception that a behavior is internally driven (e.g., Genschow, Rigoni, et al., 2017, 2019). That is, the more individuals believe in free will, the stronger their perceived intentions of other people's behavior.

Based on this research, we predicted that belief in free will is positively correlated with automatic imitation. It is important to note that this does not mean that a person who does not believe in free will would not perceive any intention and would therefore not imitate others at all. Rather, we expected individuals to lay on a continuum with individuals who do not believe in free will perceiving fewer intentions than individuals who strongly believe in free will. Consequently, we predicted that the more a person believes in free will, the more strongly he or she will engage in automatic imitation.

Interestingly, the connection between imitation and belief in free will has been discussed already by various researchers (Baer et al., 2008; Cracco, Bardi, et al., 2018; Feldman, 2016; Rigoni et al., 2012, 2013; Spengler et al., 2010). For example, Cracco, Bardi, et al. (2018) claim that "evidence suggests that psychological beliefs on topics such as free will can have pervasive effects on human performance" (p. 26). However, the link between belief in free will and automatic imitation has never been empirically tested. To fill this gap, we conducted two high-powered and preregistered studies.

Study 1 tested the predicted relation in a high-powered sample. Study 2 aimed at replicating the findings obtained in Study 1 in an even larger sample. For both studies, we applied an online version of the imitation-inhibition task and measured free will belief with the Free Will Inventory (FWI; Nadelhoffer et al., 2014). In addition, we added another belief in free will measure in Study 2 to cross-validate our findings. To test whether the predicted effect is driven by facilitation, interference, or both, we measured in both studies all three typical automatic imitation effects (i.e., congruency, facilitation, interference). We have made all material and data of this paper together with a codebook openly accessible on the Open Science Framework (OSF; <https://osf.io/5nhdb/>). Both studies were pre-registered at aspredicted.org.

2. Study 1

2.1. Method

2.1.1. Participants

In line with the recommendations for stable correlations put forward by Schönbrodt and Perugini (2013) we aimed at recruiting 250 participants. Such a number of participants would give us 80% power (one-tailed) for an effect size of $r = 0.16$. In order to compensate for pre-registered participant exclusions and a potentially high drop-out rate, we aimed at collecting data from 300 participants via Amazon's Mechanical Turk. Only MTurkers located in the US with a Hit Approval Rate over 85% were invited to participate in the study. Participants could only take part in the study with a laptop or computer. For their participation, the participants received \$1.00. Data from 293 participants were recorded (for seven participants no data was recorded). 60 participants met at least one of the pre-registered exclusion criteria (cf. <https://aspredicted.org/8jj58.pdf>) and were, thus, excluded prior to data analysis. That is, among the excluded participants, 56 had fewer than 33 trials in at least one condition and 4 did not use the right hand during the experimental phase. The final sample consisted of 233 participants (103 female, 121 male, 9 diverse) with an age between 20 and 73 ($M = 36.69$, $SD = 10.80$). Twenty-three participants were left-handed and 210 participants were right-handed.

2.1.2. Procedure

The whole online study was programmed with JavaScript using the JavaScript library jsPsych (de Leeuw, 2015). The participants first completed two practice phases to familiarize themselves with the imitation-inhibition task. In the first practice phase, they were instructed to respond within 10 trials as quickly as possible to the randomly appearing number cue "1" by lifting their index finger and "2" by lifting their middle finger. After each trial, they received accuracy feedback. If they made more than two errors within 10 trials, they had to repeat the phase until they reached the threshold of at least eight correct trials. Afterwards, the participants were asked which hand they had used and were requested to use the right hand if they had used the left hand or both hands so far. The exact presentation times and a schematic structure of a practice phase trial is displayed in Fig. 1.

In the second practice phase, images of another person's hand were additionally shown to the numbers "1" and "2" (all pictures had a resolution of 400×267 pixels). This picture depicted a model lifting either the index, the middle finger, or no finger. The participants were again asked to react to the number cue by lifting their fingers. This setup resulted in three different trial types: in congruent trials, participants responded with the same finger as the model. In incongruent trials, participants responded with another finger, and in neutral trials the participants responded with a finger while the model's hand did not execute any finger movement. This second practice phase consisted of 12 trials in total whereby neutral, congruent and incongruent trials were presented randomly. After each trial, participants received accuracy feedback. The participants had to repeat this practice phase until they made fewer than 4 errors. The exact presentation times and a schematic structure of a practice phase trial with hands is displayed in Fig. 2.

The subsequent experimental phase was built the same way as the second practice phase, with the exact same stimuli presentation times and the same interstimulus interval, except that participants received no further accuracy feedback. In total, the experimental phase consisted of 150 trials (50 incongruent, 50 congruent, and 50 neutral trials), which were presented in a randomized order. To prepare the data for analysis, we removed extremely slow reaction times in line with our preregistration. That is, latencies below (0.02%) and above (0.95%) 3 SDs of the participant's mean. We also removed trials with reaction times below 100 ms (2.36%). For the analyses of the latencies we removed erroneous trials (10.65%).

After participants completed the imitation-inhibition task, we measured their belief in free will with the Free Will Inventory (FWI; Nadelhoffer et al., 2014). That is, they indicated their agreement for 15 statements on 7-point rating scales ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The FWI consists of three subscales measuring belief in free will (Cronbach's $\alpha = 0.90$), determinism (Cronbach's $\alpha = 0.86$), and dualism (Cronbach's $\alpha = 0.94$). Dualism refers to the idea that humans have souls that are distinct from their material body. Determinism (contrary to free will) describes that there is only one possible outcome of the future. To prepare the data for analysis, for each subscale we computed sum scores by adding all answers for the respective subscale.¹

At the end, participants indicated demographical data and a few general questions on how they experienced working on the task.

2.2. Results

To test our hypotheses, we conducted inference statistics using SPSS besides the correlational analyses. Additionally, we applied Bayesian

¹ We also pre-registered an overall free will score to correlate it with the automatic imitation effects, in order to establish comparability with previous research, as this approach has been used by some researchers (Baumeister et al., 2009; Genschow, Rigoni, et al., 2017; Lynn et al., 2013; Rigoni et al., 2012, 2015). As an overall score we computed the mean of the free will, dualism, and reversed determinism subscale.

Fig. 1. Schematic representation of a practice trial with the number “2”.

Fig. 2. Schematic representation of a congruent practice trial with hand pictures.

statistics using JASP, an open source statistical package (Version 0.11.1.0; JASP Team, 2019). We also used JASP for the hypothesized correlational analyses to directly test for positive correlations.

2.2.1. Latencies

In a first step, we tested within three preregistered *t*-tests for the presence of imitation-inhibition effects in the response times. With respect to the congruency effect, the results indicate that the subjects responded more quickly in congruent trials ($M = 451.97$ ms, $SD = 72.00$), than in incongruent trials ($M = 511.28$ ms, $SD = 79.13$), $t(232) = 27.65$, $p < .001$, $d_z = 1.81$, 95% CI [1.68, 1.94]. Also, the facilitation effect was significant: the subjects responded more quickly in congruent trials ($M = 451.97$ ms, $SD = 72.00$), than in neutral trials ($M = 481.30$ ms, $SD = 72.40$), $t(232) = 23.29$, $p < .001$, $d_z = 1.53$, 95% CI [1.40,

1.65]. Finally, with respect to the interference effect, the participants responded more quickly to neutral trials ($M = 481.30$ ms, $SD = 72.40$), as compared to incongruent trials ($M = 511.28$ ms, $SD = 79.13$), $t(232) = 18.73$, $p < .001$, $d_z = 1.23$, 95% CI [1.10, 1.36]. In addition to the pre-registered analyses we corrected for multiple testing according to Bonferroni (Bland & Altman, 1995); all *t*-tests were also significant at a level of $\alpha = 0.017$.

2.2.2. Error rates

In a second step, we ran the same analyses for the error rates. In line with the latencies, we detected a congruency effect. That is, the subjects responded with fewer errors in congruent trials ($M = 0.56\%$, $SD = 0.71$) than in incongruent trials ($M = 3.00\%$, $SD = 2.32$), $t(232) = 16.58$, $p < .001$, $d_z = 1.09$, 95% CI [0.96, 1.22]. Moreover, we found a facilitation

effect meaning that the subjects responded with fewer errors in congruent trials ($M = 0.56\%$, $SD = 0.71$), compared to neutral trials ($M = 0.96\%$, $SD = 1.05$), $t(232) = 5.74$, $p < .001$, $d_z = 0.38$, 95% CI [0.25, 0.51]. Finally, we found an interference effect: the participants committed fewer errors in neutral trials ($M = 0.96\%$, $SD = 1.05$) than in incongruent trials ($M = 3.00\%$, $SD = 2.32$), $t(232) = 14.78$, $p < .001$, $d_z = 0.97$, 95% CI [0.84, 1.09]. Again all t -tests were also significant when the α -level is corrected according to Bonferroni (i.e., $\alpha = 0.017$).

2.2.3. Relation between automatic imitation and free will belief

To prepare the data for analysis, we first calculated, for the latencies and the error rates, the congruency effect by subtracting the mean values of congruent trials from those of the incongruent trials, the facilitation effect by subtracting the mean values of the congruent trials from those of neutral trials, and the interference effect by subtracting the mean values of the neutral trials from the mean values of the incongruent trials.

In order to test our hypothesis that belief in free will is positively correlated with automatic imitation we ran correlation analyses. We first correlated the congruency, facilitation, and interference effect of the latencies with all the FWI's subscales (i.e., free will, dualism, and determinism). None of the FWI's subscales correlated significantly with any of the automatic imitation indices, $ps > .106$. (see Table 1).

In a second series of analyses, we correlated the same scales with the imitation effects of the error rates. None of these correlations were significant either, $ps > .188$ (see Table 2). We do not additionally report the correlations corrected according to Bonferroni, as they were already unconservatively insignificant. Thus, our hypothesis of a positive correlation of the imitation effects with the free will scales could not be supported. Mean value, standard deviation and variance of the three subscales are listed in Table 3.

2.2.4. Bayes factors

In a final series of analyses, we tested the null hypothesis that belief in free will is not correlated with automatic imitation by applying Bayesian statistics. That is, we report the BF_{+0} , which gives the ratio with which the alternative hypothesis is favored over the null hypothesis (i.e., the smaller the BF the more it argues in favor of the null hypothesis), indicating the constrained hypothesis that the correlation is positive-only (see Schönbrodt & Wagenmakers, 2018 for an overview). We calculated the BF_{+0} with the default priors (stretched beta prior width $r = 1$) in JASP (Version 0.11.1.0; JASP Team, 2019) because we did not expect a specific estimated size of the correlation beforehand. Moreover, we report values of the Bayes factor robustness check. The robustness check provides an assessment of the robustness of the Bayes factor under different prior specifications: if the derived conclusions do not change across a range of different prior distributions, the assumption that the analysis is robust is supported. For correlational analyses, JASP provides within the robustness check the maximal BF_{+0} that can be achieved under certain prior conditions, which is the value we report for every correlation. The BF_{+0} values for the correlation between the

different free will belief scales and the imitation effects on the latencies ranged from 0.03 to 0.32, which means moderate to very strong evidence for the null hypothesis (see Table 4, cf. Jeffreys, 1998). The robustness check indicates that even with very low priors, the maximum BF_{+0} would not exceed anecdotal evidence for H1 (max $BF_{+0} < 1.70$). The same pattern was apparent for the error rates (cf. Table 5).

2.3. Discussion

In Study 1, we tested the prediction that belief in free will is positively correlated with automatic imitation measured with the imitation-inhibition task. The results did not yield a significant correlation between the typical imitation indices (i.e., congruency, facilitation, and interference) and the different free will belief subscales. Bayesian analyses indicate support for H0 suggesting that belief in free will is not correlated with automatic imitation. Nevertheless, due to the large number of unanticipated participant exclusions, which resulted in a smaller sample size than we had hoped for, it might be that our sample was too small to detect a relation between free will beliefs and automatic imitation. Thus, we ran a high-powered replication of Study 1 with twice as many participants. In addition, we added a one item slider measure of belief in free will (Gooding et al., 2018) to cross-validate our findings.

3. Study 2

3.1. Method

3.1.1. Participants

We recruited 494 participants via Amazon's Mechanical Turk to take part in the online study in return for compensation of \$1.80. On Amazon's Mechanical Turk, the same selection criteria were applied as in the first study. In line with our preregistration (<https://aspredicted.org/c3h/b7.pdf>), data from a total of 85 subjects were excluded from data analyses because they had fewer than 33 valid trials in one or more of the conditions ($n = 72$), or did not use the right hand during the experimental phase ($n = 13$). The final sample consisted of 409 subjects (187 female, 210 male, 9 diverse, 3 prefer not to say) with an age ranging from 18 to 76 ($M = 37.45$, $SD = 11.41$). Fifty-eight participants were left-handed and 351 participants were right-handed.

3.1.2. Procedure

The procedure was the same as in the first study. Additionally, we implemented a free will slider that has been previously used in the research of free will beliefs (Gooding et al., 2018; Harms et al., 2017; Protzko et al., 2016; Shariff et al., 2014) to get a direct assessment of participants' general belief in free will. Specifically, participants were asked to indicate their free will belief on the following item: "Using the slider provided, please indicate the extent to which you believe in free will". The slider represented a continuum from 0 (no belief in free will) to 100 (absolute belief in free will). The slider measurement has the advantage that the belief in free will is indicated directly on a continuum, resulting

Table 1

Pearson's correlations of the reaction time imitation effects with the free will inventory (Study 1).^a

	RT congruency	RT facilitation	RT interference	Sub free will	Sub dualism	Sub determinism
RT congruency	–					
RT facilitation	0.67***	–				
RT interference	0.81***	0.11*	–			
Sub free will	–0.06	–0.13	0.03	–		
Sub dualism	0.05	0.04	0.04	0.37***	–	
Sub determinism	0.06	0.08	0.02	–0.05	0.23***	–

Note. All tests are one-tailed, for positive correlation.

^a Pearson's correlations of the reaction time imitation effects with the overall free will score: $r = -0.03$ (rt congruency), $r = -0.09$ (rt facilitation), $r = 0.04$ (rt interference).

* $p < .05$.

*** $p < .001$, one-tailed.

Table 2Pearson's correlations of the error rate imitation effects with the free will inventory (Study 1).^a

	Error congruency	Error facilitation	Error interference	Sub free will	Sub dualism	Sub determinism
Error congruency	–					
Error facilitation	0.37***	–				
Error interference	0.88***	–0.12	–			
Sub free will	–0.01	–0.13	0.06	–		
Sub dualism	–0.003	–0.03	0.01	0.37***	–	
Sub determinism	0.05	0.02	0.04	–0.05	0.23***	–

Note. All tests are one-tailed, for positive correlation.

*** $p < .001$, one-tailed.

^a Pearson's correlations of the error rate imitation effects with the overall free will score: $r = -0.03$ (error congruency), $r = -0.09$ (error facilitation), $r = 0.02$ (error interference).

Table 3

Descriptive statistics of the free will, the dualism, and the determinism subscales (Study 1).

Measure	<i>M</i>	<i>SD</i>	<i>Var</i>
Sub free will	25.28	5.79	33.56
Sub dualism	21.95	8.24	67.92
Sub determinism	16.51	6.45	41.60

in a direct clear and unambiguous interval-scaled variable (Gooding et al., 2018; Harms et al., 2017; Protzko et al., 2016; Shariff et al., 2014).

Afterwards, participants completed the Free Will inventory (FWI; Nadelhoffer et al., 2014). Cronbach's Alpha for the subscales was $\alpha = 0.89$ for the free will subscale, $\alpha = 0.88$ for the determinism subscale and $\alpha = 0.93$ for the dualism subscale.

To prepare the data for analysis, we removed extremely slow reaction times in line with Study 1 and our preregistration. That is, we discarded latencies below (0.02%) and above (1.01%) 3 *SDs* of the participants' mean as well as trials with reaction times below 100 ms (2.00%). For the analysis of the latencies, we discarded erroneous trials (9.69%).

3.2. Results

3.2.1. Latencies

In line with Study 1, we found the typical imitation effects. With respect to the congruency effect, subjects responded more quickly in congruent trials ($M = 461.55$ ms, $SD = 88.73$) than in incongruent trials ($M = 520.46$ ms, $SD = 94.61$), $t(408) = 31.51$, $p < .001$, $d_z = 1.54$, 95% CI [1.46, 1.65]. The facilitation effect also emerged: the subjects

responded more quickly in congruent trials ($M = 461.55$ ms, $SD = 88.73$), than in neutral trials ($M = 490.32$ ms, $SD = 88.45$), $t(408) = 27.83$, $p < .001$, $d_z = 1.38$, 95% CI [1.28, 1.47]. Finally, we found a significant interference effect: the participants responded more quickly to neutral trials ($M = 490.32$ ms, $SD = 88.45$), compared to incongruent trials ($M = 520.46$ ms, $SD = 94.61$), $t(408) = 21.01$, $p < .000$, $d_z = 1.04$, 95% CI [0.94, 1.14]. All *t*-tests were also significant with the Bonferroni corrected $\alpha = 0.017$.

3.2.2. Error rates

The results of the error rates mirrored those of the latencies. First, we found the congruency effect: the subjects responded with fewer errors in congruent trials ($M = 0.69\%$, $SD = 0.98$), than in incongruent trials ($M = 2.85\%$, $SD = 2.32$), $t(408) = 19.65$, $p < .001$, $d_z = 0.97$, 95% CI [0.87, 1.07]. Moreover, we found a facilitation effect: the subjects responded with fewer errors in congruent trials ($M = 0.69\%$, $SD = 0.98$), compared to neutral trials ($M = 1.12\%$, $SD = 1.17$), $t(408) = 7.78$, $p < .001$, $d_z = 0.38$, 95% CI [0.29, 0.48]. Finally, we found an interference effect: the participants responded with fewer errors in neutral trials ($M = 1.12\%$, $SD = 1.17$), than in incongruent trials ($M = 2.85\%$, $SD = 2.32$), $t(408) = 16.68$, $p < .001$, $d_z = 0.83$, 95% CI [0.73, 0.92]. Again, all *t*-tests for the error rates were also significant with the Bonferroni corrected $\alpha = 0.017$.

3.2.3. Relation between automatic imitation and free will belief

We ran the same multiple correlation analyses as in Study 1 with one exception; we included the free will slider as a further measure of free will belief. Similar to Study 1, for the latencies, none of the correlations between any of the automatic imitation indices and the free will belief subscales reached significance, $ps > .116$ (see Table 6). When correlating the same free will belief subscales with the imitation effects of the error rates, again, none of these correlations reached significance, $ps > .161$

Table 4

Bayes factors for latencies for all subscales of the free will inventory (Study 1).

Measure	RT congruency		RT facilitation		RT interference	
	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀
Sub free will	0.05	1.00 (at $r = 0.0001$)	0.03	1.00 (at $r = 0.0001$)	0.12	1.003 (at $r = 0.004$)
Sub dualism	0.18	1.24 (at $r = 0.004$)	0.13	1.06 (at $r = 0.004$)	0.15	1.15 (at $r = 0.004$)
Sub determinism	0.20	1.31 (at $r = 0.004$)	0.32	1.70 (at $r = 0.009$)	0.10	1.00 (at $r = 0.0001$)

Note. For all tests, the alternative hypothesis specifies that the correlation is positive.

r = prior width.

Table 5

Bayes factors for error rates for all subscales of the free will inventory (Study 1).

Measure	Error congruency		Error facilitation		Error interference	
	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀
Sub free will	0.07	1.00 (at $r = 0.0001$)	0.03	1.00 (at $r = 0.0001$)	0.20	1.30 (at $r = 0.004$)
Sub dualism	0.08	1.00 (at $r = 0.0001$)	0.06	1.00 (at $r = 0.0001$)	0.10	1.00 (at $r = 0.0001$)
Sub determinism	0.16	1.15 (at $r = 0.004$)	0.10	1.00 (at $r = 0.0001$)	0.14	1.10 (at $r = 0.004$)

Note. For all tests, the alternative hypothesis specifies that the correlation is positive. r = prior width.

Table 6Pearson's correlations of the reaction time imitation effects with the free will inventory and the free will slider (Study 2).^a

	RT congruency	RT facilitation	RT interference	Sub free will	Sub dualism	Sub determinism	Free will slider
RT congruency	–						
RT facilitation	0.65***	–					
RT interference	0.84***	0.13***	–				
Sub free will	–0.09	–0.09	–0.05	–			
Sub dualism	0.05	0.01	0.06	0.27***	–		
Sub determinism	–0.03	–0.01	–0.04	–0.04	0.28***	–	
Free will slider	–0.01	–0.04	0.01	0.65***	0.25***	–0.17	–

Note. All tests are one-tailed, for positive correlation.

*** $p < .001$, one-tailed.

^a Pearson's correlations of the reaction time imitation effects with the overall free will score: $r = -0.01$ (rt congruency), $r = -0.04$ (rt facilitation), $r = 0.02$ (rt interference).

(see Table 7). Mean value, standard deviation and variance of the three subscales are listed in Table 8.

3.2.4. Bayes factors

To test whether our data supports H_0 , we ran Bayesian analyses. The BF_{+0} values for the latencies ranged from 0.02 to 0.22, which means moderate to very strong evidence for the null hypothesis (see Table 9). As the Bayesian robustness checks indicate, the maximum BF_{+0} would not exceed anecdotal evidence for H_1 ($\max BF_{+0} < 1.62$) and most of the values would even not exceed a value above 1.00 (i.e., values less than or equal to 1 mean that there is no evidence at all for H_1), which strongly supports the evidence for the null hypothesis in this study as well.

The same pattern emerged for the error rates (see Table 10). The BF_{+0} values strongly support the null hypothesis.

3.3. Discussion

In a high-powered experiment, we again tested the prediction that belief in free will is positively correlated with automatic imitation as measured with the imitation-inhibition task. The setup of this second study was the same as for the first one, with two exceptions. First, we doubled the sample size. Second, we added a direct and continuous free will belief slider measure (Gooding et al., 2018). Replicating the results obtained in Study 1, we did not find a significant correlation between the typical imitation-inhibition indices (i.e., congruency, facilitation, and interference) and one of the free will belief scales, or the slider measure.

4. General discussion

People automatically imitate others' behaviors (Cracco, Bardi, et al., 2018; Heyes, 2011) and this tendency increases when they perceive other people's actions as intentionally driven (Liepelt et al., 2008). Yet an open question is whether individuals who generally perceive others' behaviors as internally driven would imitate more strongly. A factor that is strongly associated with perceived intentions, and the perception that

Table 8

Descriptive statistics of the free will, the dualism, the determinism subscales, and the free will slider (Study 2).

Measure	M	SD	Var
Sub free will	25.55	5.83	33.95
Sub dualism	22.89	8.10	65.68
Sub determinism	16.44	6.48	42.01
Free will slider	81.91	20.28	411.46

others' behavior is internally driven, is belief in free will (Genschow, Rigoni, et al., 2017, 2019). Consequently, we hypothesized that the more individuals believe in free will, the more strongly they automatically imitate others. We tested this hypothesis in two high-powered studies (total $N = 642$). In Study 1, automatic imitation did not correlate with belief in free will measured with the Free Will Inventory (FWI; Nadelhoffer et al., 2014). In Study 2, we replicated this null finding in an even larger online sample of nearly 500 participants. Additionally, we added a free will slider measure (Gooding et al., 2018) to cross-validate our findings. Again, no significant relation was found between belief in free will and automatic imitation. These findings have important theoretical implications and call for further empirical investigations.

4.1. Theoretical implications

Although previous research has shown that certain personality traits such as autism (Bird et al., 2007), narcissism (Hogeveen & Obhi, 2013), as well as empathic traits and the ability to take another person's perspective (Cracco et al., 2015) correlate with automatic imitation, other research was not able to replicate some of these findings (Butler et al., 2015; Cracco, Bardi, et al., 2018; Galang & Obhi, 2020; Genschow, van Den Bossche, et al., 2017; Müller et al., 2013; Newey et al., 2019). In line with these failed replications, we find despite high power no support for the idea that interindividual differences are linked to automatic imitation. A reason for the difficulty to detect correlations with the imitation-inhibition task may lay in the key feature of the construction

Table 7Pearson's correlations of the error rate imitation effects with the free will inventory and the free will slider (Study 2).^a

	Error congruency	Error facilitation	Error interference	Sub free will	Sub dualism	Sub determinism	Free will slider
Error congruency	–						
Error facilitation	0.36***	–					
Error interference	0.87***	–0.15	–				
Sub free will	0.01	0.03	–0.001	–			
Sub dualism	–0.07	–0.05	–0.05	0.27***	–		
Sub determinism	–0.07	–0.10	–0.02	–0.04	0.28***	–	
Free will slider	0.03	0.05	0.01	0.65***	0.25***	–0.17	–

Note. All tests are one-tailed, for positive correlation.

*** $p < .001$, one-tailed.

^a Pearson's correlations of the error rate imitation effects with the overall free will score: $r = 0.004$ (error congruency), $r = 0.03$ (error facilitation), $r = -0.01$ (error interference).

Table 9

Bayes factors for latencies for all subscales of the free will inventory and the free will slider (Study 2).

Measure	RT congruency		RT facilitation		RT interference	
	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀
Sub free will	0.02	1.00 (at $r = 0.0001$)	0.02	1.00 (at $r = 0.0001$)	0.03	1.00 (at $r = 0.0001$)
Sub dualism	0.17	1.36 (at $r = 0.004$)	0.07	1.00 (at $r = 0.0001$)	0.22	1.62 (at $r = 0.004$)
Sub determinism	0.04	1.00 (at $r = 0.0001$)	0.06	1.00 (at $r = 0.0001$)	0.04	1.00 (at $r = 0.0001$)
Slider free will	0.05	1.00 (at $r = 0.0001$)	0.04	1.00 (at $r = 0.0001$)	0.07	1.00 (at $r = 0.0001$)

Note. For all tests, the alternative hypothesis specifies that the correlation is positive.

r = prior width.

Table 10

Bayes factors for error rates for all subscales of the free will inventory and the free will slider (Study 2).

Measure	Error congruency		Error facilitation		Error interference	
	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀	BF ₊₀	max BF ₊₀
Sub free will	0.08	1.00 (at $r = 0.0001$)	0.11	1.04 (at $r = 0.004$)	0.06	1.00 (at $r = 0.0001$)
Sub dualism	0.03	1.00 (at $r = 0.0001$)	0.03	1.00 (at $r = 0.0001$)	0.03	1.00 (at $r = 0.0001$)
Sub determinism	0.03	1.00 (at $r = 0.0001$)	0.02	1.00 (at $r = 0.0001$)	0.04	1.00 (at $r = 0.0001$)
Slider free will	0.12	1.11 (at $r = 0.004$)	0.17	1.38 (at $r = 0.004$)	0.07	1.00 (at $r = 0.0001$)

Note. For all tests, the alternative hypothesis specifies that the correlation is positive.

r = prior width.

of this task. The imitation-inhibition task delivers very strong effects and even under different modulations, the basic congruency effect is still very robust and reliable (Brass et al., 2000; Cracco, Bardi, et al., 2018; Genschow, van Den Bossche, et al., 2017; Westfal et al., 2021). The strength of the task may come along with little variation between participants, which could decrease the likelihood of finding correlations with other measures (Benesty et al., 2009). Thus, the intrinsic characteristics of the imitation-inhibition task could be a reason as to why it is difficult to detect correlations with interindividual factors, such as the belief in free will, for instance. Future research may aim at restructuring the task to achieve higher interindividual variations.

Given the difficulty to find correlations between the imitation-inhibition task and personality scales, the question arises as to whether the null findings are specific to personality scales, or whether this finding generalizes to other forms of top-down modulations. This question relates to a current discussion on the usefulness of measuring automatic imitation with a stimulus-response compatibility task. Ramsey (2018) argues that it is not possible to measure imitation with reaction-time-based tasks, because the reaction time indices in the task are the result of a combination of several different underlying processes. These processes are neither necessarily related to imitation, nor to any other form of social behavior. Consequently, the task might not be a suitable candidate to measure top-down modulated imitation. In contrast to this view, Cracco and Brass (2019) argue that the imitation-inhibition task was designed as a laboratory measurement of mimicry. In their opinion, reaction times measure covert imitative response tendencies associated with some (but not all) types of overt imitation. Indeed, there is research supporting this notion showing that the imitation-inhibition task can be socially modulated with *experimentally* manipulations. For example, subjects imitate a human hand more strongly than a robot hand (Press et al., 2006), an in-group member than an out-group member (Genschow & Schindler, 2016; Rauchbauer et al., 2016), a goalless action more strongly than a goal-directed one (Chia-varino et al., 2013), social gestures more strongly compared to antisocial gestures (Cracco, Genschow, et al., 2018), or when the belief in animacy of the hand is increased (Liepelt & Brass, 2010)—to name just a few examples. However, there is also research that has not been able to replicate some of these results. For example, recently the in-out group effect on imitation could not be replicated (De Souter et al., 2021; Genschow et al., in press). Other research had difficulties in replicating the influence of animacy on automatic imitation (Press et al., 2006). Our findings contribute to this literature by showing that top-down

modulations of automatic imitation are more difficult than previously assumed.

As previous research had difficulties in finding meaningful relations between interindividual differences and automatic imitation assessed with the imitation-inhibition task, the question arises as to whether this applies to other forms of imitation too. Indeed, individuals' tendency to imitate others can be measured in different ways and the imitation-inhibition task is just one of many measures of imitative behavior. For, example, when measuring mimicry, that is, the spontaneously occurring tendency to imitate others in actual social situations, research within the last two decades found that a variety of different interindividual differences correlate with mimicry. For example, perspective-taking abilities (Chartrand & Bargh, 1999), affiliation motives (Johnston, 2002; Lakin et al., 2003), or field dependence (van Baaren, Horgan, et al., 2004) have all been found to correlate with mimicry behavior. However, more recent research testing the influence of several personality scales on mimicry within a highly powered experiment could not replicate previous findings (Genschow, van Den Bossche, et al., 2017). That is, mimicry did not correlate with several personality traits including empathy, perspective taking, autism traits, and traits related to self-other-focus (e.g., individualism vs. collectivism, need to belong). As there are just a few large-scale investigations on the relationship between personality traits and mimicry, future research is warranted to more thoroughly investigate whether and how interindividual differences relate to mimicry and other forms of imitation. Such research could also use other imitation paradigms that disentangle goal- from movement-based imitation (e.g., Genschow, Hansen, et al., 2019; Hansen & Genschow, 2020) to investigate top-down modulations on different forms of imitation.

4.2. Potential reasons for the null finding

Our results suggest that belief in free will does not correlate with automatic imitation. At the same time, one may argue that the proposed correlation could be masked for a variety of reasons.

First, it might be that the link between belief in free will and automatic imitation could not be detected because the assessed measures are unreliable. However, it is important to note that the free will belief scale we used is one of the most reliable scales to measure free will belief (Liu et al., 2021; Nadelhoffer et al., 2014; Santin et al., 2018). Also, the assessed imitation-inhibition task is very reliable and more reliable than other imitation measures, such as mimicry tasks (Genschow, van Den

Bossche, et al., 2017). Thus, we regard it as unlikely that unreliable measurements account for the null finding.

Second, it might be that our samples were too small to detect the hypothesized effect. However, the Bayesian analyses speak against this reasoning, as they detected moderate to very strong support for the null hypothesis. Moreover, even if one would find an effect with a larger sample, the effect would be rather small and, thus, most likely negligible.

Third, it could be that belief in free will not only relates to higher perceived intentions, but also a stronger focus on the self, which could have counteracted the predicted effect. Previous research has shown that a focus on the self (relative to others) reduces automatic imitation (Brass et al., 2009; Brass & Spengler, 2009; Genschow, Schuler, et al., 2019; Hogeveen & Obhi, 2011; Leighton et al., 2010; Spengler et al., 2010; van Baaren et al., 2003; Wang & Hamilton, 2013). Based on this finding, Spengler et al. (2010) speculated that belief in free will “might help counteract predominant imitation-driven behavior” (p. 105). Based on this reasoning, it might be that a focus on the self counteracts the influence of perceived intentions on automatic imitation. If so, these two processes may cancel each other out, explaining the present null effect. However, it is important to note that the speculated link between free will belief and self-other focus has never been empirically tested. There are only some investigations suggesting a relation between free will beliefs and pro-social attitudes (Baumeister et al., 2009; Vohs & Schooler, 2008)—a link that does not seem to be very stable as several failed attempts in replicating this basic idea indicate (Crone & Levy, 2019; Nadelhoffer et al., 2020). Moreover, as recent research has shown that a focus on the self is not as strongly related to automatic imitation as this has been previously assumed (Khemka et al., 2021; Rauchbauer et al., 2020), we regard the alternative explanation that a focus on the self counteracted our assumed effect as rather unlikely. Nevertheless, future research may aim to test the link between free will beliefs, self-other focus and automatic imitation.

4.3. Limitations and further directions

Despite several implications of our studies, we need to acknowledge several limitations. First, it is important to note that our correlative approach does not allow for causal conclusions. However, as experimental approaches, in which free will beliefs are manipulated, do not typically produce stronger effects than correlational approaches (Genschow et al., 2021), the conclusion that belief in free will and automatic imitation are not related would most likely not be challenged by further experimental investigations.

Second, our study cannot draw any conclusions about the extent to which perceived intentions themselves influence automatic imitation, because we merely tested whether belief in free will, but not perceived intentions per se, correlates with automatic imitation. Although prior studies (Liepelt et al., 2008) have previously assessed the link between perceived intentions and automatic imitation, future research may replicate this finding to strengthen the link between perceived intentions and automatic imitation.

Third, our study is equally unable to test whether free will beliefs affect the perception of intentionality. Previous research has repeatedly shown that belief in free will is related to the perception of intentions even when people observe very abstract actions (e.g., Genschow, Rigoni, et al., 2017, 2019). Nevertheless, these studies as well as our present investigation do not allow testing of whether belief in free will increases perceived intentions in the observed finger lifting movements. Future research may consider examining this relation more directly to resolve any ambiguities in the link between free will beliefs and automatic imitation.

4.4. Conclusion

The two presented studies provide new insights into automatic

imitation. In both of our high-powered studies, we found no correlation between automatic imitation and belief in free will, suggesting that the two constructs are likely unrelated. Therefore, in line with current research (e.g., Butler et al., 2015; Galang & Obhi, 2020; Genschow, van Den Bossche, et al., 2017; Müller et al., 2013) our findings suggest that the relationship between automatic imitation and interindividual factors is less universal and generalizable than previously reported in the literature.

CRedit authorship contribution statement

Mareike Westfal: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Visualization. **Jan Crusius:** Conceptualization, Methodology, Validation, Investigation, Resources, Writing – review & editing, Supervision, Funding acquisition. **Oliver Genschow:** Conceptualization, Methodology, Validation, Resources, Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

None.

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