

Reaction time indices of automatic imitation measure imitative response tendencies

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Author Note

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Abstract

In his review, Ramsey (2018) argues that it is currently unclear what reaction time indices of automatic imitation measure due to lacking research on their validity and domain-specificity. In our commentary, we argue that this conclusion is based on two misconceptions, namely that automatic imitation was designed as a laboratory measure of motor mimicry and that psychometric approaches to validity can readily be applied to experimental settings. We then show that reaction time indices of automatic imitation measure covert imitative response tendencies. Furthermore, while irrelevant for validity, we argue that these indices are associated with some, but not necessarily all, types of overt imitation. Finally, we argue that mapping out the brain networks does not suffice to understand the brain processes underlying imitative control.

1. Introduction

Humans have a strong tendency to imitate each other. In the literature, two approaches have been developed to measure this tendency. Using stimulus-response compatibility tasks, cognitive psychology focuses on *automatic imitation* – the degree to which congruent observed actions facilitate and incongruent observed actions impede responses on an unrelated task (Brass et al., 2000; Cracco, Bardi, et al., 2018; Heyes, 2011). In contrast, social psychology focuses on *motor mimicry* – the frequency with which individuals copy the behavior of a confederate during live or virtual social interactions (Chartrand & Bargh, 1999; Chartrand & Lakin, 2013; Chartrand & van Baaren, 2009). Both approaches were developed independently, stem from different research fields, and address different research questions (Cracco, Bardi, et al., 2018).

In his review, Ramsey (2018) looks at reaction time indices of automatic imitation (RT-AI) and concludes that it is currently unclear what they measure due to lacking research on their validity and domain-specificity. In brief, he argues that there is little support for a relationship between RT-AI and overt copying behavior as well as mounting evidence that inhibiting automatic imitation involves not social (Brass, Ruby, & Spengler, 2009), but cognitive brain networks (Bien, Roebroek, Goebel, & Sack, 2009; Cross, Torrisi, Losin, & Iacoboni, 2013; Darda, Butler, & Ramsey, 2018). In this commentary, we will critically discuss both claims. First, we will argue that validating cognitive tasks requires a different approach than validating psychometric tests, and that a proper validation clearly identifies RT-AI as a measure of covert imitative response tendencies. Second, we will argue that, to understand imitative control, it is necessary to investigate not only brain networks but also brain processes.

2. Automatic imitation measures imitative response tendencies

In his paper, Ramsey (2018) takes a psychometric approach to validity. Starting from the idea that theoretically related constructs should correlate (Campbell & Fiske, 1959; Cronbach & Meehl, 1955), he examines the correlation between RT-AI, on the one hand, and motor mimicry and social variables, on the other hand. Based on the absence of such correlations (Genschow et al., 2017), he then concludes that the validity of RT-AI remains to be established. However, this approach has two important problems. First, RT-AI was not designed to measure motor mimicry or social functioning. Instead, it was designed to measure covert imitative response tendencies. As such, while interesting, these correlations tell us little about the validity of RT-AI. Second, psychometric approaches to validity cannot readily be applied to experimental settings because cognitive tasks, in contrast to psychometric tests, are designed to minimize rather than maximize inter-individual differences and are therefore ill-suited to study correlations (De Schryver, Hughes, Rosseel, & De Houwer, 2016; Hedge, Powell, & Sumner, 2017).

Instead, validation in experimental settings involves evaluating a task's internal validity – the degree to which the task manipulates the processes it was designed to manipulate (Leary, 2008). While conceptually related to construct validity (Cronbach & Meehl, 1955), internal validity is assessed not by exploring the extent to which a task correlates with other tasks, but rather by exploring the different processes it manipulates (Leary, 2008). Thus, in this view, to assess the validity of RT-AI, it has to be investigated whether RT-AI manipulates automatic processes and whether these processes are imitative in nature. Importantly, these questions have been investigated extensively ever since RT-AI was developed (Bertenthal, Longo, & Kosobud, 2006; Brass et al., 2000; Brass, Bekkering, & Prinz, 2001; Stürmer et al., 2000).

To answer the first question, whether RT-AI is an automatic process, it has to be investigated whether it is a fast process and whether it requires intention, attention, and awareness (Moors & De Houwer, 2006). As summarized in Cracco et al. (2018), research has shown that RT-AI is a relatively transitory process (Catmur & Heyes, 2011), that persists in the absence of attention (Catmur, 2016; Cracco & Brass, 2018), and requires no intention to imitate (Heyes, 2011), but does require awareness of at least the stimuli (Mele, Mattiassi, & Urgesi, 2014). This indicates that RT-AI is automatic with respect to many – but not all – aspects of automaticity, meriting its qualification as an automatic process (Cracco, Bardi, et al., 2018; Heyes, 2011).

To answer the second question, whether RT-AI measures imitative response tendencies, imitation first has to be defined. Here, we will define imitation as observing someone performing a movement and then performing the same movement with the same body part (Heyes, 2011). According to this definition, if I stretch my arms after seeing you stretch your arms, I imitated you. However, if I instead stretch my legs or flex my arms, I did not imitate you. Thus, to speak of imitation, both the movement and the effector have to be copied. Therefore, to show that RT-AI measures imitative response tendencies, it has to be shown that action observation in these tasks triggers the execution of the same action with the same effector.

To test this hypothesis, Leighton & Heyes (2010) manipulated movement and effector compatibility in the same experiment by asking participants to open or close their hand or mouth while at the same time also seeing an opening or closing hand or mouth. The results revealed main effects of both movement and effector compatibility, indicating, respectively, that opening (closing) actions triggered opening (closing) responses and that hand (mouth) actions triggered hand (mouth) responses. Crucially, however, there was also an interaction between movement and effector compatibility, indicating that movement compatibility was

stronger when the effector was congruent and effector compatibility when the movement was congruent. As these last two situations correspond to what is typically measured in automatic imitation tasks, the results of Leighton & Heyes (2010) clearly show that movement and effector priming work together to shape RT-AI, and as such validate RT-AI as a measure of imitation.

Nevertheless, it might still be that RT-AI does not measure movement and effector compatibility, but instead measures a confounded process, such as spatial compatibility (e.g., Heyes, 2011; Jansson, Wilson, Williams, & Mon-Williams, 2007). In contrast to this view, however, there is now strong evidence that automatic imitation, albeit reduced, is still present when spatial compatibility is controlled (Bertenthal et al., 2006; Catmur & Heyes, 2011; Cracco, Bardi, et al., 2018; Heyes, 2011), indicating that spatial processes contribute but do not explain RT-AI.

In sum, the conclusion that it is unclear what RT-AI measures can be traced back to the misconception that RT-AI is something it was not designed to be, namely an index of motor mimicry or social variables, and to the misconception that psychometric validity approaches can readily be applied to experimental settings. Instead, validity in experimental settings is established by evaluating the extent to which a task manipulates what it was designed to manipulate (Leary, 2008). Using this framework, it becomes clear that RT-AI measures the automatic activation of a specific action with a specific effector, caused by observing that action. As such, it effectively measures covert imitative response tendencies (Cracco, Bardi, et al., 2018; Heyes, 2011).

3. Does automatic imitation also measure overt imitation?

Nevertheless, while irrelevant to establish validity, it remains interesting to investigate how RT-AI relates to overt imitation. As noted by Ramsey (2018), there is currently little evidence that RT-AI and motor mimicry are correlated (Genschow et al., 2017). However, motor mimicry is known to be unreliable, making it difficult to interpret such correlations (Genschow et al., 2017). Moreover, the null relation with motor mimicry does not mean that RT-AI is unrelated to all types of overt imitation. For example, Heyes (2011) describes a children's game in which the players have to follow the instructions of a leader who, at the same time, performs a congruent or incongruent action. Similar to automatic imitation tasks, this causes the players to sometimes mistakenly copy the leader's actions instead of his/her instructions. Crucially, because it applies the same procedure, this game is much more likely to correlate with RT-AI than motor mimicry, which uses a very different procedure instead. Thus, in this view, task overlap may determine the relationship between covert and overt imitation (Genschow et al., 2017).

Supporting this view, a close look at automatic imitation tasks reveals that they do measure overt imitation, in addition to covert imitation. More specifically, these tasks are not only characterized by slower responses but also by more errors on incongruent trials than on congruent trials (Cracco, Bardi, et al., 2018). Since errors are overt responses, they measure overt instead of covert imitation. This thus clearly shows that automatic imitation can be used to index overt copying behavior. However, it also suggests that different types of imitation may rely on different mechanisms. For instance, research has shown that automatic imitation is driven by corticospinal facilitation of the observed action (Bardi, Gheza, & Brass, 2017), while motor mimicry appears to be driven by generalized sensorimotor arousal instead (van Schaik, Sacheli, Bekkering, Toni, & Aglioti, 2017). In the same vein, evidence indicates that

dissociable neural structures are involved in controlling both types of imitation (Hogeveen et al., 2015).

In conclusion, while there is currently little evidence that RT-AI can be used as an index of motor mimicry (Genschow et al., 2017), it does not follow that it cannot be used as an index of overt imitation. Indeed, the lack of correlations with motor mimicry could be caused by limited reliability, procedural differences, or different underlying processes (Genschow et al., 2017). A similar point is to be made about the relationship between RT-AI and social variables. That is, while there is currently little evidence that RT-AI predicts social personality factors, this does not mean that RT-AI is impervious to social influences. Indeed, like many experimental tasks, RT-AI was not designed to capture inter-individual differences (Hedge et al., 2017). Further, as acknowledged by Ramsey (2018), there is now increasing evidence that RT-AI is sensitive to social manipulations (Wang & Hamilton, 2012), not only from low-powered but also from high-powered studies (e.g., Cracco, Genschow, Radkova, & Brass, 2018).

3. Brain networks are not brain processes

In addition to validity, Ramsey (2018) also analyzes the brain networks underlying imitation inhibition, and concludes that there is now strong evidence that this relies on cognitive networks, such as the multiple-demand (MD) network (Bien et al., 2009; Cross et al., 2013; Darda et al., 2018), and not on social networks, such as the theory of mind (ToM) network (Brass et al., 2009). As this conclusion is based on high-powered research (e.g., Darda et al., 2018), it clearly calls into question earlier, low-powered, research reporting ToM activity (Brass, Derrfuss, & von Cramon, 2005; Brass et al., 2009; Brass, Zysset, & von Cramon, 2001). However, while the involvement of the MD network points towards executive

processes (Duncan, 2010), it does not necessarily follow that these processes contribute causally to the inhibition of imitation. Instead, the MD network might also fulfill an auxiliary role by detecting response conflict or regulating attentional control (Botvinick, Braver, Barch, Carter, & Cohen, 2001).

Similarly, the lack of ToM activity does not rule out that social processes, like self-other distinction (Brass et al., 2009), contribute to imitative control (see also Darda et al., 2018). Indeed, recent theories have argued that social cognition does not recruit dedicated social networks but instead recycles basic brain operations for social purposes (Anderson, 2010; Parkinson & Wheatley, 2013, 2015). For instance, it has been argued that attentional reorienting and ToM activate overlapping brain networks because they use overlapping brain processes (Corbetta, Patel, & Shulman, 2008). In other words, while we agree that recent evidence casts doubt upon social theories of imitative control (e.g., Brass et al., 2009), we caution against the danger of equating brain networks with brain processes. Instead, to distinguish between cognitive processes, such as response inhibition, and social processes, such as self-other distinction, it is necessary not only to map out the involved brain networks, but to also manipulate the assumed brain processes. So far, research using this experimental approach suggests that both self-other (e.g., Spengler et al., 2010) and executive processes (e.g., van Leeuwen, van Baaren, Martin, Dijksterhuis, & Bekkering, 2009) contribute to controlling imitation. However, more, and especially more strongly powered, research will be needed to definitively reveal the respective role of cognitive and social processes in imitation inhibition.

4. Conclusion

In this commentary, we critically discussed the claim that it is currently unclear what RT-AI measures (Ramsey, 2018). Specifically, we argued that it is based on two misconceptions. First, automatic imitation was not developed to measure motor mimicry but rather to investigate covert imitative response tendencies. Second, the validity of an experimental paradigm is determined not by its construct validity but by its internal validity. Extensive research supports the internal validity of the automatic imitation paradigm. As for the brain circuits involved in automatic imitation, we agree with Ramsey (2018) that the literature would benefit from an universal adoption of recent methodological developments, as well as from a greater emphasis on distributed brain models. Yet, while these models constitute an important step in developing an integrated automatic imitation theory, they currently remain largely underspecified at the process level. Further developing these models, possibly using computational modeling approaches, therefore holds great promise in bringing the field forward.

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