

# Imitation reconsidered

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*In the past 20 years or so, the psychological research on imitation has flourished. However, our working definition of imitation has not adequately adapted in order to reflect this research. The closest that we've come to a revamped conception of imitation comes from the work of Michael Tomasello. Despite its numerous virtues, Tomasello's definition is in need of at least two significant amendments, if it is to reflect the current state of knowledge. Accordingly, it is our goal in this paper to reformulate Tomasello's definition of imitation in order to account for both the latest empirical findings and the conceptual considerations that follow from them. Specifically, we argue that a satisfactory definition of imitation ought to be formulated as follows: imitation is the reproduction of an observed behavior where the agent imitating (1) recognizes the behavior of the demonstrator as goal-directed and (2) has some particular interest in or concern for replicating the precise technique performed by the author of the observed action.*

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## 1. Introduction

Over the past 20 years, psychological research on imitation has flourished.<sup>1</sup> The literature has provided us with insights into the differences between action reproduction in humans and non-human primates, and the implications of these differences for the emergence in phylogeny of a suite of distinctively human skills.<sup>2</sup> However, our definition of imitation has not adequately adapted to reflect advances in the empirical literature.

One prominent voice in debates about the nature and significance of imitation belongs to Michael Tomasello, whose account of imitation we take as our starting point. Since the 1990's, Tomasello (1996, 1999a, 1999b; Boesch & Tomasello, 1998; Tomasello & Carpenter, 2005; Tomasello, Kruger, & Ratner, 1993; Tomasello &

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Rakoczy, 2003) has argued that imitative learning is sensitive both to the goals of the demonstrator and also to the particular behavioral strategy that the demonstrator uses in order to achieve his or her goals. According to an early formulation of this position, “the archetype of imitative learning . . . [is the] reproduction of both behavior and its intended result” (Boesch & Tomasello, 1998, p. 599). That is, true imitation requires copying intentional states and intentional actions.

Tomasello’s definition of imitation has numerous virtues. However, it is in need of amendment if it is to reflect more precisely the current state of empirical knowledge. Accordingly, in this paper we reformulate Tomasello’s definition of imitation to account for both the latest empirical findings and the conceptual considerations that follow from them. To be clear, we do not see this reformulation as a fundamental challenge to Tomasello’s position. Rather, it is a friendly amendment to, and clarification of, a conception of imitation, some important aspects of which have been thought unmotivated, overlooked, or misconstrued by others. As will become apparent, Tomasello himself has made some of the same suggestions that we emphasize below.

In particular, we advance two amendments to Tomasello’s definition of imitation, the first a weakening and the second a strengthening of it. The first amendment focuses on what it means to reproduce an intentional goal state and the second concerns the normative import, in imitation, of the means by which a goal is achieved.<sup>3</sup>

Specifically, we claim that in order for a behavior to qualify as imitation, one need not fully understand the exact intentional content of the demonstrator’s goal state. Rather, a subject needs only to recognize the demonstrator’s behavior as intentionally produced and goal-directed.<sup>4</sup> This distinction is a conceptual one that distinguishes identifying a behavior as goal-directed from identifying the particular intentional content of the goal.

Secondly, we add that the intention to imitate must involve, in some minimal way, not just the goal to reproduce the outcome of another’s behavior but, additionally, an aim to reproduce the very same behavior that one has observed. In saying this, we emphasize that we are not claiming that these goals (behavior matching and outcome matching) are an agent’s only goals in imitation. Therefore we do not deny that one could have—and imitators often do have—additional reasons for wanting to reproduce observed behaviors precisely—for example, for further affiliative or instrumental goals. Nor are we claiming that a subject must always succeed in executing observed techniques precisely. One could intend to copy a technique precisely, and in doing so imitate, even if aspects of the behavior were imperfectly copied. However, we insist that for imitation to be present, the subject must intend to reproduce precisely the techniques of an observed behavior and not just its outcome. On this point, we try to refine an idea that Tomasello himself has previously defended (most explicitly in the postscript to Tomasello, 2009).


To this end, we argue for the following definition: imitation is the reproduction of an observed behavior where the agent imitating (1) recognizes the behavior of the demonstrator as goal-directed and (2) has some particular interest in or concern for replicating the precise technique performed by the author of the observed action.

Before proceeding, we emphasize that this article is neither a review of the empirical literature nor an attempt at conceptual analysis. Rather, this is an exercise in theoretical philosophy of psychology. We are concerned with elucidating the conceptual landscape surrounding the notion of imitation, given the empirical evidence currently available. On that basis, we craft a robust working definition.

## 2. Tomasello on Imitation

One virtue of Tomasello's definition of imitation is that it can be used to distinguish between emulation, mimicry, and imitation. With some additional caveats, the same definition can also be used to distinguish between stimulus and local enhancement, and response facilitation. Briefly, stimulus and local enhancement occur when the behavior of one individual causes the properties of an object or location to become salient to another. Response facilitation occurs when the presence of one individual performing an action temporarily increases the probability of an observer performing the same action.<sup>5</sup>

Emulation learning, as Tomasello defines it, is "the process whereby an individual observes and learns some dynamic affordances of the inanimate world as a result of the behavior of other animals and then uses what it has learned to devise its own behavioral strategies" (Boesch & Tomasello, 1998, p. 598). In its earlier manifestations, this definition made no reference to understanding the intentional states of others.<sup>6</sup> More recent accounts have been revised to accommodate the possibility that, in emulation learning, one could act in order to achieve results that one had identified others as intending to achieve. Whiten, Horner, Litchfield, and Marshall-Pescini (2004) refer to this as "goal emulation," to be contrasted with "result emulation." The former but not the latter would require the ability to attribute goals to others.

Crucially, no formulation of emulation learning requires that emulators reproduce the particular strategy that they observe a demonstrator use. Rather, emulation learning concerns learning about the nature and relation of objects in the world and how individuals might best exploit environmental affordances in order to achieve their goals: "in emulation learning an observer watches someone manipulate an object and learns something new about the object as a result, which may then be used to devise its own behavioral strategy" (Tomasello & Rakoczy, 2003, p. 129). The focus is therefore on the object manipulated and the goals that can be fulfilled  result, but not on the manipulating agent. Tomasello (1996, 1999a; Call et al., 2000) and Tomasello & Rakoczy, 2003; Tennie, Call, & Tomasello, 2009, 2012) claims that emulation is the primary way by which non-human primates engage in social learning: by focusing on the outcomes of others' activity, but not on the precise actions that they perform.

In contrast to emulation learning, "the archetype of imitative learning ... [is the] reproduction of both behavior and its intended result" (Boesch & Tomasello, 1998, p. 599). Imitative learning is responsive to both the intentions of the demonstrator and to the particular behavioral strategy that the demonstrator adopts. That is, for Tomasello, a creature that imitates reproduces both the means and the ends of an observed, goal-directed behavior.<sup>7</sup> Importantly, this is because the imitator

understands the means and ends as being related in such a way that the imitator has an interest in reproducing both. Specifically, the imitator recognizes the goal of the demonstrator and is able to understand how the observed action-plan is related to satisfying the demonstrator's goal. Accordingly, the imitator seeks to copy both the plan and the end at which it is aimed.

Moreover, because imitation requires the recognition and replication of the intentions of a goal-directed action, it can also be distinguished from mimicry. Following Tomasello et al. (1993), "mimicry is defined as the replication of a model's actions in the absence of any insight into why those actions are effective, or even what goal they serve" (Want & Harris, 2002, p. 3). Mimicry is concerned with copying behaviors but is insensitive to the intentional states of the demonstrator.

An example of mimicry might be a parrot reproducing human speech. This kind of vocal replication reproduces the detailed vocal patterns of an intentional behavior, but perhaps without any insight into a speaker's communicative goals. The parrot may understand neither the conventional meaning of the uttered words, nor the intentions with which a speaker uses them. In that case, *ceteris paribus*, the parrot might be no less likely to copy gibberish sounds produced non-purposively than the linguistic, goal-directed utterances of a human speaker.<sup>8</sup>

Alternative accounts of the nature of imitation are possible and have been defended elsewhere. For example, Whiten (2011; Whiten & Ham, 1992; Whiten et al., 2004) has consistently adopted a more inclusive account of imitation, as a process "in which B learns some aspect(s) of the form of an act from A" (Whiten & Ham, 1992, p. 250). The requirement that only *some aspects* of a behavior need be learned is, in the words of Whiten and Ham,

intended to acknowledge that imitative copying of the form of another individual's act may vary between the faithful and the poor and encompass only a subset of the elements potentially copyable. (1992, pp. 250–251)

While this definition is similar to Tomasello's in some respects, on Whiten's formulation imitation does not require that a subject aims at matching observed techniques precisely. This inclusiveness is motivated by the wholly reasonable emphasis that imitation and emulation lie on a continuum of more and less faithful copying, such that this definition aims to capture the continuities that exist between cases of animal and human learning. Indeed, Whiten and Ham profess themselves happy with the "concise and everyday"—and maximally inclusive—definition of imitation first proposed by Thorndike (1898, p. 50): "learning to do an act from seeing it done."<sup>9</sup> As a result of this inclusiveness, Whiten and colleagues have labeled a wider range of behaviors imitative than Tomasello. While this is understandable, for reasons that we will make clear there are good reasons for avoiding this approach.

Other recent accounts of imitation also give less emphasis to the distinction between high- and low-fidelity mechanisms of social learning. For example, Heyes distinguishes between simple imitation—"when an observer copies body movements that are already



[Q4] part of his behavioural repertoire” (2013, p.)—and complex imitation, which “occurs when an observer copies a ‘novel’ sequence of body movements” (2013, p.). Since these distinctions reflect a different set of motivations from those we explore here (namely, issues pertaining to the “correspondence problem” of how observers can recognize that others’ body movements correspond to their own), we note this difference but do not explore it further.

In contrast to Whiten and Heyes, the account that we defend accords great significance to the fact that imitation is a high-fidelity learning mechanism that aims at faithful reproduction. Understanding the distinctions between varieties of copying (not least imitation and emulation) is crucial for understanding the nature of human imitation and also for identifying both the similarities and differences between the imitation of humans and the copying behaviors of other creatures.<sup>10</sup> A central goal of recent work on imitation has been to identify a set of cognitive tools that would suffice to explain the emergence in human ontogeny and phylogeny of a set of distinctively human cultural traits, including conventional language and complex, causally opaque tool sets that embody the wisdom and learning of generations of agents. In this respect, a series of authors have emphasized that imitation—conceived of as a high-fidelity transmission mechanism—would suffice to explain the social transmission of these traits (Acerbi, Jacquet, & Tennie, 2012; Gergely & Csibra, 2005; Moore, 2013a; Richerson & Boyd, 2005; Tennie et al., 2009; Tomasello, 1999b; Tomasello et al., 1993). Since less faithful transmission mechanisms—in particular, those that make no requirement on reproducing all aspects of an observed technique—would not suffice to explain the emergence of these features of human culture, robust conceptual considerations motivate characterizing imitation as we do.

Although we recognize that there is clear evidence of social learning in many species of non-human animals (see, e.g., Laland & Galef, 2009; Moore, 2013b), and thus that the field of comparative social learning is marked by continuity as well as discontinuity, it is empirically clear that humans possess some skills for social learning that are not shared by our non-human relatives. The account of imitation that we specify makes clear, we hope, one central source of this difference. It explains why, for example, imitative learners are likely to be capable of learning causally opaque (Gergely & Csibra, 2005) and conventional behaviors (Moore, 2013a; Tennie et al., 2012) when emulative learners cannot. Alternative, more inclusive accounts of imitation are less well-equipped to specify the sources of this discontinuity.

Since Tomasello’s definition of imitation best captures the valuable set of distinctions upon which we will rely, this is the definition with which we will start.

### 3. Imitation and Intentions

#### 3.1. Tomasello and Understanding Intentional Content

According to Tomasello, Carpenter, Call, Behne, and Moll (2005), a fundamental feature of imitation is its identification of the mental states of others. This

characteristic allows Tomasello to specify a close connection between the functional role of imitation in cognitive development and mindreading. However, it also makes imitation cognitively demanding (Tomasello, 1996, 1999a; Tomasello & Rakoczy, 2003; Tomasello et al., 2005). After all, according to Tomasello, an imitator must grasp not only that a behavior is goal-directed, but also the particular content of a demonstrator's goal and the way in which the performed action-plan is related to achieving that goal. The final point is particularly important, since it "determines precisely what of the other's behavior [an imitative learner] seeks to reproduce" (Tomasello, 1996, p. 324).

Such an understanding of intentional contents and their relation to instrumental action requires substantial knowledge on the part of the imitating agent, perhaps placing demands on imitation that are too high. In the remainder of this section, we argue for a minimal requirement of goal recognition on the part of the imitating subject and argue that an imitator need not replicate or share a demonstrator's goals.

### 3.2. *Selective Imitation*

When considering the relationship between mind-reading and imitation, the first question we ask is whether and what role an understanding of intentional states plays in imitation. Empirical evidence suggests that understanding a goal state, or recognizing some behavior as goal-directed, is central to imitation. Numerous studies demonstrate that children imitate selectively (Bellegamba & Tomasello, 1999; Carpenter, Akhtar, & Tomasello, 1998; Gergely, Bekkering, & Kiraly, 2002; Huang, Heyes, & Charman, 2002; Meltzoff, 1995; Schwier, van Maanen, Carpenter, & Tomasello, 2006). They do not blindly copy movements, but reproduce only actions identified as goal-directed or intentional.

Meltzoff (1995) presented children with a demonstration of an adult attempting but failing to perform a target action. In this study, Meltzoff found that "infants were as likely to perform the target after seeing the adult 'trying' as they were after seeing the real demonstration of the behavior itself" (1995, p. 845). That is, children inferred the goal of the failed attempt at action, and reenacted not the failed performance but its successful execution. This means that children recognized the purpose of the action and imitated the behavior that they took to be intentional, and not simply the movements or action-sequence that they observed. Similarly, Carpenter et al. (1998) found that infants imitated intentional actions that were marked by the word 'there' almost twice as often as they imitated accidental actions that were marked with the word 'whoops'.

Further, Gergely et al. (2002) found that children who observed a demonstrator turn on a light box using her head when her hands were occupied were not nearly as likely (21% imitated) to imitate the action as children who watched the demonstrator turn on the light box using her head when her hands were free (69% imitated). The authors concluded that children who saw the hands-occupied demonstration inferred that the head use was *not itself* an intentional part of the demonstrator's action-plan.<sup>11</sup> In contrast, children in the hands-free condition understood the model's use of her



head as an essential part of the action; there was a reason for the demonstrator to use her head. Thus, again, we are led to the conclusion that children only imitate actions that they understand to be have been performed deliberately. Taken together, these findings show that imitation is not an unreflective response to observing the movements of conspecifics but, rather, incorporates a sensitivity to the intentional aspect of intentional actions.

It is, then, clear that the recognition of a behavior as goal-directed plays an important role in the imitation behaviors of human children. But to what extent must imitative learners understand the content of an intention in order for them to imitate it selectively?

### 3.3. *Intention-First or Imitation-First?*

At this point, we turn to some meta-theoretical considerations in order to determine what our conception of imitation should yield. As we saw above, Tomasello's definition of imitation requires a fairly demanding understanding of intentional contents and their connection to action. Gergely and Csibra criticize this commitment to "cognitive transparency" as having

an *overly narrow predictive scope* as it generates wrong predictions concerning *what* will be imitated. Tomasello's theory predicts that infants will imitate only those behaviors whose underlying intentions and rational design they can fully understand through simulation. Therefore, as it stands, his theory cannot account for the imitative learning of truly *novel* behavioural means that are unpredictable on the grounds of physical-causal efficiency considerations and that, therefore, remain cognitively 'opaque' to the infant. (2005, p. 470)

Furthermore, on Tomasello's account, children could not learn about the causal and intentional structure of an action through imitation. After all, before children know how something works, they are not in a position to appreciate the complex intentional structure of the demonstrator's goals and plans. And if they are not in such a position, then they cannot satisfy Tomasello's requirements for imitation.

As Meltzoff has argued, Tomasello's way of framing the criterion for imitation strips imitation of much of its explanatory power, putting "the cart before the horse" (2005, p. 56). After all, children couldn't learn about a demonstrator's goals through imitation if imitating already requires knowledge of the contents of these goals. Were this the case, then imitation could not play a role in contributing to the development of a capacity for understanding other minds.

If we want a theory of imitation that is consistent with children's developing an understanding of other minds partly through imitation, then Tomasello's definition must be revised. Of course, we might want to reserve the name 'imitation' for that very special kind of copying that is cognitively transparent. However, in doing this, imitation would cease to play an explanatory role in children's acquisition of both causal knowledge and knowledge of other minds. From a theoretical point of view, we find it preferable to allow cognitively opaque copying behaviors to qualify as imitation.

3.4. *The Minimal Requirement*

In this section, we will attempt to construct a minimal criterion for imitation, which does justice to the centrality of intentional behavior to the imitative strategy but which also allows for an understanding of the contents of intentional states to be acquired through imitation. To this end, we propose that when it comes to understanding the mental states of others, imitation requires only that the imitator recognize an observed behavior as goal-directed. Contra Tomasello, it does not require that the demonstrator's intentional states be cognitively transparent to the imitator.

This requirement keeps mental states central to imitation, while allowing imitation to function as a learning mechanism through which we can learn about the mental states of others. From a meta-theoretic perspective, it seems that a theory that can deliver these results is superior to a theory where imitation remains explanatorily impotent.

When we consider the various ways in which the intentional states of others may be recognized, it is clear that one can recognize an action as goal-directed while remaining ignorant of both (1) the exact content of that goal and (2) the way in which a particular observed action is organized to satisfy that goal.

For example, suppose that one day one saw two men on the roof next door, waving various flags and gesturing in a seemingly systematic way. In seeing this, one might wonder what the men were doing. Importantly, one need not wonder *if* what they were doing was intentional or goal-directed, so much as *what* the exact purpose of their behavior was. One might recognize their actions as goal-directed without having any insight into the nature of their goals.

Suppose further that one learned from a friend that the men on the roof were training homing pigeons. At this stage, one would have learned (something of) their goals, but without understanding how their flags and gestures related to the training of the pigeons. One might then go up onto the roof oneself in order to reproduce their movements and, in trying to call pigeons down from the sky, learn about how the previously observed actions related to the men's goals.

In this instance we should consider the reproduced behavior as an instance of imitation. This is because the most explanatorily powerful role for imitation is captured by the minimal requirement and the minimal requirement demands only that one recognize the observed actions as goal-directed. So, even without insight into the details of the intentional strategy of the pigeon trainers, one would qualify as imitating them.

Significantly, Tomasello himself accepts that there are various stages at which the understanding of other minds is more or less developed. For example, Tomasello et al. (2005) admit that sharing intentions is preceded by a stage where children are not able to interpret the content and relation of means to ends, but only to distinguish animate and inanimate actions. Similarly, by appreciating that cognitive development comes in phases, for genuine imitation, we can require more than the capacity to distinguish animate from inanimate movements, but less than full-blown cognitive transparency. That is, we can happily state that the minimal requirement for imitation demands the recognition of an action as goal-directed. In this way, we can get more than the animate/inanimate distinction, since animate actions such as accidents can lack goal-



directedness. But we get less than cognitive transparency, since we do not require either that the imitator recognize or replicate the exact content of the goal, or that he or she understand the complex ways in which a behavioral strategy is related to that goal.

This kind of minimal requirement allows for a coarse-grained understanding of other minds to develop into more fine-grained, complex knowledge through imitation. It allows us to see the process by which imitation fosters the understanding of other minds both without losing sight of the centrality of intentional states in imitation and without over-intellectualizing the process.

### 3.5. *Partial Intentions and Cross-Purposes*

Another reason to adopt the minimal requirement is that it allows us to count as imitation cases where others' goals are only partially understood, and cases where goals that are understood are reproduced only in part. This may happen unintentionally, as a result of the imitator's ignorance, or it may happen because the imitator has goals that are at cross-purposes with the demonstrator.

An obvious instance of diverging intentional states can be observed in almost every study of imitation. After all, in these studies, the demonstrator's goal is not simply to perform some particular task, but, more importantly, to test the subject's response. For instance, in the Gergely et al. (2002) study, the goal of the child and demonstrator diverge since the child's goal is to turn on the light while the demonstrator's goal is to see if the child will imitate her light-turning-on behavior. The child clearly imitates the behavior that she understands as intentional, but she most likely lacks the capacity to interpret the full scope of the demonstrator's goals. This is unlike the homing pigeon case since there is partial overlap in intentional structure between the imitator and demonstrator, but it is similar in that it lacks full correspondence. We see no good reason for why this kind of divergence should disqualify the child's behavior from counting as a genuine instance of imitation.

It is also worth noticing that a virtue of framing the intentionality requirement in a minimal way is that it allows us to avoid the inevitably hairy questions of thresholds. That is, we don't have to ask, e.g., what percentage or aspect of an intentional state must be shared in order for it to count as expressing the same intention?

In light of the above theoretical considerations, it seems clear that we should not demand of imitation that the detailed intentional content of a goal be either recognized or replicated. The minimal requirement offers us an intuitively plausible account of imitation where learning about the mental states of others fits nicely into a naturalistic framework.

### 3.6. *Challenge 1: When We Do Know*

A legitimate concern one may have with the minimal requirement is that it doesn't do justice to the plethora of studies, which demonstrate that imitators' understanding of intentional states and actions are often highly organized, hierarchical, and fine-

grained. After all, the Meltzoff (1995) study shows that children not only understand the demonstrator as a goal-directed agent, but actually attribute to her particular intentional contents. Further, numerous studies indicate that imitators interpret observed intentional actions in terms of complex, hierarchical structures and nuanced social contexts, varying their imitative behaviors in line with past experience, situational demands, and the understanding of a subject's goals and sub-goals (Baldwin, Baird, Saylor, & Clark, 2001; Bauer, Wenner, Dropik, & Wewerka, 2000; Bekkering, Wohlschlagel, & Gattis, 2000; Brugger, Lariviere, Mumme, & Bushnell, 2007; Byrne, 2003; Byrne & Russon, 1998; Nielsen, 2006; Sommerville & Woodward, 2005; Travis, 1997; Whiten, Flynn, Brown, & Lee, 2006).

In response to this concern, it should be noted that while the minimal criterion *does not require* that children possess identical goals to those of the demonstrator, it *does not rule out* instances where they might. That is, there is no requirement that an imitator should not recognize or be able to reproduce a complex, observed means-ends strategy. The only commitment of this amended account is that the imitator *need not* recognize and reproduce the exact goals of an observed intentional action in order for him or her to qualify as imitating it. Accordingly, as children become more sophisticated imitators, it is natural to assume that they will come to understand more and more about the world and about the intentional states of those whom they are imitating. This is consistent with the minimal requirement.

#### 4. Imitation and Technique

In this section, we will consider what the content of an imitator's intentional states must be in order for his or her behavior to qualify as a genuine instance of imitation. Focusing on a study by Horner and Whiten (2005), we argue that in the absence of a criterion that makes explicit reference to a subject's interest in or concern for reproducing the precise means of an observed intentional action, we are left in a confounding and unsatisfactory interpretative situation regarding imitative behaviors. Subsequently, we review evidence that demonstrates that human children often care about reproducing the precise means of an observed action despite their irrelevance or inefficiency in bringing about the child's goals. We conclude by introducing the "technique-centric orientation" as a criterion for imitation. This criterion requires that an imitator have a concern for or interest in producing the precise actions—including, for example, manual gestural techniques and styles of tool-use—that they observe others perform.<sup>12</sup>

##### 4.1. Chimpanzees, Intentions, and Confounds

In a beautiful study, Horner and Whiten (2005) presented chimpanzees and three- and four-year-old children with a demonstration of a complex series of actions aimed at opening a locked box that contained a reward. The demonstration was given in two variant conditions. In the transparent condition, the participants were able to see how the experimenter's actions were causally related to the opening of the box. By contrast,

in the opaque condition, the causal structure of the box was hidden from the view of participants. Therefore, when the experimenter's demonstration included a causally irrelevant behavior, the participants were unable to see it as such.

Horner and Whiten found that chimpanzees imitated the behavioral sequence demonstrated, including the useless movement, in the opaque condition but not in the transparent condition. So, once the chimpanzees were able to see that the movement was causally irrelevant for opening the box, they no longer included it in their own performance. In contrast, children continued to reproduce the causally irrelevant action in both the opaque and the transparent condition. Even after identifying the movement as causally irrelevant,<sup>13</sup> children continued to reproduce it. Importantly, this means that children, even though they had access to the relevant causal knowledge, did not use this to perform the most efficient strategy for opening the box. Horner and Whiten conclude that children prefer an imitative strategy, while chimpanzees sometimes imitate and sometimes emulate.

The behaviors produced by chimpanzees in this study demonstrate that non-human primates are capable of reproducing a complex sequence of observed actions.<sup>14</sup> However, contra Horner and Whiten, we would suggest that they do not demonstrate that chimpanzees switched between imitating and emulating. In fact, because different possible explanations of this data are possible—chimpanzees could either be emulating in both conditions, or switching from imitation to emulation between conditions—this study is useful for elucidating a deeper conceptual concern about imitation. Namely, this study highlights the fact that any definition of imitation that does not make reference to the intentional orientation of the copying subject will be insufficient to account for a key feature of imitation.

We suggest that the Horner and Whiten study does not show that chimpanzee imitate in the opaque condition because the experiment cannot rule out the possibility that chimpanzees are employing the same strategy in both conditions: namely, the strategy of using the most efficient means for opening the box. If we can describe the chimpanzee as doing the same thing in both conditions, then we see no good reason to conclude that in one condition the chimpanzee is imitating while in the other it is emulating. While the chimpanzee certainly employs a different sequence of actions in the two conditions, we should not conclude that it employs a different strategy. After all, in the opaque condition the chimpanzee might just mistakenly judge that the most efficient strategy for opening the box is the same as the strategy observed in the demonstration. Since on our account, imitation requires not just a fortuitous reproduction of actions one has seen another produce, but some interest in copying the precise form of those actions, we are in a position to differentiate between these two options.

We suggest that the transparent condition in this study should be interpreted as having important implications for understanding the chimpanzee's behavior in the opaque condition. After all, one of the purposes of testing a subject in different contexts is so that we can generalize our findings from more clear cases to more tendentious cases. In this study, the tendentious case is the opaque condition where one can interpret the behavior of the chimpanzee as either imitation or emulation. As

such, the findings of the transparent condition should be used to shed light on what is happening in the opaque condition. If this is correct, then it seems plausible to interpret Horner and Whiten's findings in the following manner: though it may initially seem that the chimpanzee is imitating in the opaque condition, what we see as a result of the chimpanzee's behavior in the transparent condition is that the chimpanzee is not imitating but emulating. Because the chimpanzee lacks relevant information in the opaque condition, it behaves in a way that is observationally indistinguishable from imitation. However, the chimpanzee is actually emulating as is made clear by the transparent condition. The chimpanzee is not concerned with copying the technique modeled by the experimenter—only with opening the box. Notably, at no point in either condition must we describe the chimpanzee as having any interest in replicating the actions of the demonstrator.

Of course, this interpretation of the Horner and Whiten study does not prove that the chimpanzee could not be imitating, and that the Horner and Whiten interpretation is impossible. But it does entail that their interpretation is underdetermined by the data, whereas our more conservative approach tracks an important distinction that is revealed by it.

By adopting a conservative approach, we learn that imitation requires more than recognizing an action as goal-directed and then incidentally reproducing that action while pursuing the same goal. Presumably, the chimpanzee is able to do all that (Call & Tomasello, 1998). What the chimpanzee has not been shown to do, however, is to have any interest in reproducing the precise nature of the observed action. The particular techniques used by the observed individual are not a source of interest or concern for the chimpanzee; not valued as an end-in-itself. In contrast, this strategy seems to be of primary importance for children.

Crucially, in giving an account of imitation, if we do not make reference to the intentions for which an action is reproduced, then we do not have the resources to distinguish between imitation and emulation in circumstances like the opaque condition. But, clearly, there is a relevant difference between cases where an observed behavior is reproduced coincidentally and cases where the same behavior is reproduced conscientiously.

As a further objection to the Horner and Whiten interpretation, the expectation that chimpanzees imitate in some circumstances should lead to the prediction that they imitate in other circumstances, too. In particular, if chimpanzees really do imitate, they should also succeed in tasks in which success would be made likely only if they could reproduce the precise techniques used by a model. In fact, empirical evidence suggests that this is not the case. For example, Tennie et al. (2009) found that human children but not chimpanzees succeeded in a task in which they were required to fashion a straw hook with which to reel in an out-of-reach reward. This action was selected for the experiment precisely because it was not likely to be discovered by participants independently of their having paid careful attention to the demonstrated action. Indeed, in a no-demonstration control, neither child nor ape participants created a loop.

In a similar study, Tennie et al. (2012) tested chimpanzees' ability to recreate an arbitrary gesture performed by a conspecific demonstrator. They found that while one chimpanzee (out of 15) performed a familiar gesture in exchange for a reward, that individual did not learn a new behavior in the same circumstances. Studies of the ability to learn conventional actions like words and gestures are particularly important for the identification of imitation because conventional behaviors—including, for example, the communicative use of words—are arbitrary. As such they are highly unlikely to be acquired through individualistic trial and error learning and cannot be inferred from the causal properties of an environment. Luck aside, they can only be learned by paying attention to and reproducing faithfully another's behavior. That is, while conventional solutions could be learned by participants using an imitative learning strategy, they are highly unlikely to be employed by participants using an emulative strategy. In this respect, they differ from the tool use task paradigms used by Whiten and colleagues, which can potentially be solved in a variety of non-social and minimally social ways.<sup>15</sup>

The fact that chimpanzees fail in tasks that set out to disambiguate imitative and emulative learning strategies should both make us skeptical of the conclusion that chimpanzees imitate, and reinforce our motivation to amend our definition of imitation to better isolate the features that differentiate imitation and emulation.

With respect to this need for disambiguation, we emphasize that in imitation, observers should intend not just to reproduce the outcomes of others' intentional actions but, additionally, to match precisely the actions that they produce in pursuit of these goals—in a manner that indicates that this careful matching of the behavior is itself a goal of the imitating subject (an end-in-itself).

#### 4.2. *Overimitation in Children*

Importantly, it is quite easy to see that children do care about reproducing the particular means of an observed intentional action for reasons that either trump or ignore efficiency and practicality. We know this because there is strong empirical evidence that children frequently overimitate (Lyons, Young, & Keil, 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Children reproduce an observed action even when they have determined that the action is not the most efficient way for them to accomplish a task. This means that, for children, reproducing the precise form of an observed behavior is valued over and above merely reproducing results.

Lyons et al. (2007) demonstrated that even after training three to five-year-old children to recognize a feather-tapping action as irrelevant to an object retrieval task, the same children still performed that action when undertaking the same task for themselves. Strikingly, children that did better at identifying an action as causally irrelevant were *no less* likely to reproduce it. Additionally, even when children were explicitly instructed not to replicate the “silly” or “extra” action, they continued to do so.

Surprisingly, another study showed that children overimitate not less but more when they are better equipped with causal knowledge. McGuigan et al. (2007) found that five-year-olds were more likely to imitate a causally irrelevant action after watching it modeled

on a TV than three-year-olds were. Although other studies have found that children are less likely to imitate when they find a task easy than when it is difficult (Williamson, Markman, & Meltzoff, 2008), the McGuigan et al. (2007) findings suggests that the overimitation strategy is not just a consequence of a lack of causal understanding.

Taken together, these studies suggest that the particular means by which goal-directed actions are instantiated play a central role in the orientation that children occupy when copying observed behaviors. As such, we should conclude that the reproduction of the means or techniques of intentional actions are themselves valued by children. They copy actions not just because they take them to be causally necessary, but because they are geared towards faithful copying of actions in general.

#### 4.3. *The Technique-Centric Orientation*

The technique-centric orientation of imitation, which might usefully be contrasted with a tool-centric or outcome-centric orientation of emulation, shows why a definition of imitation must make explicit the necessity, not simply of an agent to recognize and reproduce the results of a particular intentional strategy, but to conscientiously replicate particular features of that strategy. Using this criterion we can both justify the difference between imitation and emulation in observationally identical circumstances and also explain why humans overimitate.

In short, humans appear to occupy what we call a “technique-centric orientation,” which drives us to care about the means of intentional actions in a way that is not limited to concern for the outcome, and where attention to the means is not limited to attention to the environmental affordances that must be manipulated for an action to be successful, but to the particular (and sometimes causally superfluous) techniques with which actions are performed. The technique-centric orientation makes the precise techniques used in intentional action both salient and valuable to children, allowing instrumental actions themselves to become objects of attention and concern.

Though the emphasis of this amendment differs from Tomasello’s original analysis of imitation, Tomasello (2009) himself has stated that these action strategies occupy a special place in the intentional orientation of children. In his 2009 postscript to the early paper “The question of chimpanzee culture,” Tomasello writes:

But although this study [Tomasello and Carpenter (2005)] does show that chimpanzees can focus on a demonstrator’s internally represented goal in a social learning situation—her desired outcome rather than the actual outcome—it does not speak to whether they are concerned with the behaviors or behavioral techniques used as means to achieve those goals. (2009, p. 216)

Tomasello goes on to write that:

The clear result is that human children are much more focused on the actual actions of the demonstrator, whereas chimpanzees are much more focused on the outcome of her actions—either the actual outcome (the result) or the desired outcome (her goal). (2009, p. 217)



Furthermore:

Humans seem more focused on actions than are chimpanzees, who are mainly focused on outcomes and goals. (2009, p. 219)

Moreover, a number of studies (not least Tennie et al., 2009, 2012) have been run to show the functional significance of this distinction. As such, there are very good reasons to incorporate this kind of preoccupation or concern with technique into our revised definition of imitation. Once we accept these amendments, we see that the proper way of understanding imitation is as follows:

*Imitation is the reproduction of an observed behavior where the agent imitating (1) recognizes the behavior of the demonstrator as goal-directed and (2) has some particular interest in or concern for replicating the precise technique performed by the author of the observed action.*

#### 4.4.

##### 4.4.1. Challenge The social

When trying to explain the unusual phenomenon of human imitation, theorists often appeal to reasons that involve our uniquely social and cooperative nature. The motivations for imitation and overimitation are then cashed out in profoundly social terms—for instance, as desires for identification, affiliation, intersubjective connection, or shared intentionality (Byrne & Russon, 1998; Horner & Whiten, 2005; Lakin & Chartrand, 2003; Nielsen & Blank, 2011; Nielsen, Simcock, & Jenkins, 2008; Over & Carpenter, 2009; Tomasello et al., 2005). As Lyons et al. write,

It has been assumed that children overimitate not for deep cognitive reasons but simply because of implicit social demands or out of imitative habit. For example, one account of overimitation emphasizes children's willingness "to copy to satisfy social motivations, to fulfill an interpersonal function of promoting shared experience with others." (2007, p. 19751; quoted in Nielsen, 2006, p. 563. See Uzgiris, 1981 and Tomasello et al., 2005 for similar claims.)

Moreover, further research supports the conclusion that children are more likely to copy the behavior of familiar individuals than strangers (Maratos, 1982), and in-group members rather than out-group members (Buttelmann, Zmyj, Daum, & Carpenter, 2013). Children are also more likely to reproduce actions performed by esteemed individuals than by those whom others have ignored (Chudek, Heller, Birch, & Henrich, 2012). These results seem to add force to the possibility that there is a strong connection between social affiliation and imitation.

The claim that imitation is socially motivated is consistent with our emphasis on the technique-centric orientation, since motivations for the latter can be spelled out in social terms. For example, children might care about the means of an intentional action because such concern leads to identification and affiliation with the model. The social story and the technique-centric orientation are therefore complementary. Nonetheless, the role of social goals alone, without a focus on technique matching, cannot provide us with an adequate account of imitation.

There are two reasons why the social motivation story is insufficient: the first is empirical and the second conceptual.

First, Lyons et al. (2007) provide evidence that the social aspect of overimitation is not exclusively what drives children to copy irrelevant or ineffective actions. In their study, an experimenter demonstrated how to open a jar using an action sequence that included an irrelevant feather-tap. She then left the test-room, having granted the child permission to retrieve the toy while she was gone. Presumably, if the motivation of the child in overimitating was fundamentally aimed at social gain, then the experimenter's absence should have reduced the frequency with which the child reproduced the causally ineffective action. However, Lyons et al. found that the experimenter leaving the room had no impact on overimitation. This does not prove that social conditions never impact the reasons for overimitation, but it does show that they cannot be only relevant factors.

Second, motivations for shared, social experiences are also conceptually insufficient to account for imitation. After all, a general desire for social reward is compatible with an endless variety of behaviors, none of which are imitation. For example, a child looking to affiliate might also open the jar without a feather-tap and then give the demonstrator a hug. Alternatively, she could open the jar and give the reward contained inside to the demonstrator. What better way to foster affiliation than by the giving of gifts? The technique-matching central to imitation must reflect some deeper goal than affiliation alone.

#### 4.4.2. Challenge Normativity

A related challenge to the technique-centric orientation comes from the literature on norm learning (Kenward, 2012; Rakoczy, Werneken, & Tomasello, 2008). Several authors have argued that, for humans, imitation's primary function is to transmit norms from adults to children. Since human practices often involve tools that are cognitively opaque (Gergely & Csibra, 2005; Csibra & Gergely, 2006, 2009) and a whole host of arbitrary cultural conventions (Moore, 2013a; Rakoczy et al., 2008), a psychological mechanism for the transfer of norms is vital. Given that individual learning of these practices would be even more inefficient than the occasional, irrational copying of unnecessary actions, the seemingly maladaptive practice of overimitation would, in fact, allow adults to pass on norms to future generations in an effective manner.<sup>16</sup>

Kenward (2012) presents a nice study providing evidence of norm learning through imitation. After watching a demonstration of a goal-directed task that includes an unnecessary action, children both overimitate and use normative language to protest and criticize a puppet who has not included the unnecessary action in her performance of the task. Even after the puppet has successfully achieved her goal with the unnecessary action omitted, children insist that she has acted improperly. This suggests that imitation plays an important role in the learning of social and cultural norms over and above the learning of instrumental actions.

As with the social explanation above, the technique-centric orientation and norm learning are not mutually exclusive. In fact, in order for norm learning to get off the

ground, it is vital that a theory of imitation does justice to the exact part of an action that is relevant for learning norms through imitation. And that is exactly where the technique-centric orientation comes in: to specify *techniques* of actions as relevant. As with the social explanation above, we can easily allow that children have a concern for the precise form of a goal-directed action because such a concern allows them to learn arbitrary cultural, social, and functional norms. What remains central, however, is that it is *the technique* of an action and not some other aspect of it that is targeted in imitative learning.

#### 4.4.3. Challenge natural pedagogy

One last apparent challenge to the technique-centric orientation comes from the natural pedagogy approach of Csibra and Gergely (Csibra & Gergely, 2006, 2009; Gergely & Csibra, 2005) about the role of ostension in driving imitative behavior. Csibra and Gergely argue that imitation and overimitation is best accounted for by appeal to a natural learning system that is sensitive to communicative intent, where this is indicated by a demonstrator's production of ostensive cues. When, in light of a model's ostensive behavior, children interpret her as communicating something important, the child reproduces the demonstrated action whether it is efficient or not. Children would therefore imitate selectively because of their understanding of the model's communicative intent.

As with the preceding challenges, we see no conflict between our account of imitation and the pedagogy view.<sup>17</sup> It may be that children become particularly motivated to imitate when they recognize that the performance of the action was directed to them communicatively—as if a speaker were telling them to “do this.” Nonetheless, in such interactions we would emphasize that it is *the technique* and not some other aspect of the demonstration—that is, not the ostensive cues themselves—which become the objects of focus and concern for the child. Thus, while natural pedagogy is compatible with our amendment, an account of imitation will be incomplete without reference to the technique-centric orientation.

We have left the requirement that children value reproducing the precise forms of observed actions purposely open-ended in order to accommodate various explanations of the motivations that drive imitation. Indeed, we emphasize that stipulating that imitation requires a not-merely instrumental concern for high-fidelity copying is not to give an account of the possible ways in which that not-merely instrumental concern can be cashed out. It's likely that it will turn on numerous factors, including considerations of affiliation (Over & Carpenter, 2012), social esteem (Chudek et al., 2012), the knowledge states of demonstrators (Buchsbaum, Gopnik, Griffiths, & Shafto, 2011), the presence or absence of ostensive cues (Gergely & Csibra, 2005), the imitators' confidence in their ability to succeed in a task (Williamson et al., 2008), and perhaps even the novelty of the behavior demonstrated. Current empirical evidence does not decide between competing hypotheses. Consequently, the existence of competing ways of cashing out this feature of technique-centric orientation does not serve as a challenge to the amendment.

**5. The Paradox**

Before closing, we'd like to make one final point. There is an obvious tension between findings that indicate that children are rational, selective imitators and findings that show them to be illogical, inefficient overimitators. Whiten et al. express this confusion by writing that

the picture of humans as irrational (over-) copiers contrasts with another set of striking findings that have documented what appears to be just the opposite. The work of Gergely et al. (2002), in which even 14-month olds avoided copying an adult performing unusual actions when the adult was constrained to act in this way, was described by the authors as 'rational imitation'. Other studies have shown that children's copying can be selective, discounting accidents (Carpenter et al., 1998) and showing sensitivity to signs of pedagogic engagement (Csibra & Gergely, 2006) even in infancy. Just where the boundaries fall (and why) between, on the one hand, 'mindless' or blinkered over-copying and, on the other hand, sophisticated and rational selectivity, in both child and adult, now emerges as an exciting and challenging territory to research more deeply. (2009, p. 2425)

Over and Carpenter (2012) have attempted to solve this paradox by highlighting social considerations, and Gergely and Jacob (2012) have suggested that pedagogical consideration might also contribute to an explanation of why children overimitate. However, neither account explains the complex array of cases in which children overimitate.

Over and Carpenter (2012) argue that imitation is profoundly social in nature. Accordingly, they suggest that by looking at the imitation paradox through a social lens, a solution can be found. They

propose that the fidelity with which a child copies an action can be explained through a combination of the child's own (learning/and or social) goals in the imitative situation, the child's identification with the model, and with the social group in general, and the social pressures experienced by the child within the imitative situation. (2012, p. 182)

According to Over and Carpenter, depending on the relevant goals and factors at play, a child will either tend to overimitate or refrain from engaging in imitative behaviors. They suggest that—at least in general—the greater the social pressures on the child and the more social the child's goals, the more likely the child will be to overimitate. Conversely, the more instrumental the child's goals, the more selective he or she will be.

While this may often be the case, the social imitation hypothesis does not explain the findings of several studies. For example, in many studies showing overimitation in children—not least Horner and Whiten (2005), Lyons et al. (2007), and McGuigan, Makinson, and Whiten (2011)—children seem to have independent, instrumental learning goals.

Gergely and Jacob (2012) suggest a solution to the paradox that is based on pedagogy. They argue that when a model uses ostensive cues in a communicative manner then children will tend to overimitate but when the model is non-communicative, then children will not. There are several studies that show a connection between ostensive

communication and imitation, and it is these studies upon which Gergely and Jacob base their claims (Brugger et al., 2007; Kiraly, 2009; Kiraly, Csibra, & Gergely, 2004, unpublished manuscript; Nielsen, 2006; Southgate, Chevallier, & Csibra, 2009). However, the natural pedagogy theory gets into trouble because other studies show that there is a double dissociation between communication and imitation.

The Gergely et al. (2002) study is an instance where ostensive cues are present but overimitation does not occur. In that study, children observed a model turn on a light box with her head in two conditions: one in which the model's hands were free and clearly placed on the table and another where her hands were occupied holding a blanket. The model used ostensive cues in both conditions<sup>18</sup> but children only imitated in the hands-free condition. Additionally, Wood, Kendal, and Flynn (2012) found that children were more likely to copy causally irrelevant actions performed by adults than by another child. Although ostension was not an independent variable in this study, the difference was presumably not driven by the more ostensive behavior of the adults. Rather, it would seem to reflect a heuristic assumption that adults know better than children.<sup>19</sup> Consequently, we can conclude that it is not merely the presence of ostensive cues that determines children's imitative strategies.

While there may be many reasons why children imitate, the definition of imitation that we defend can nonetheless say something to explain away some aspects of the apparently paradoxical nature of children's imitation. The fact is that we can separate selective imitation from illogical overimitation by recognizing that the former involves goal-directed behaviors, while the latter, with all of its impractical, illogical facets, concerns the technique-centric orientation. In this way, we predict that children should be selective imitators when it comes to copying intentional actions. That is, they should be less likely to reproduce actions that they deem not to have been performed intentionally. In this respect, they are rational. However, once they determine that an action and its technique are performed intentionally, they may be "illogical" in not parsing out the necessary from the unnecessary elements of a detailed action-plan. Of course, though, this absence of logic should be qualified—since a side-effect of "irrational" imitation may well have been an adaptive ability for learning conventional behaviors.

The tendency to overimitate techniques, but not unintentional behaviors, are not contradictory since they are inherently concerned with different aspects of imitating. Just as being rational about money but irrational about love does not create a paradox, being rational about intentions but irrational about techniques need not force us into confusion.

## 6. Conclusion

We have presented various empirical and conceptual considerations for settling on the following definition of imitation:

*Imitation is the reproduction of an observed behavior where the agent imitating (1) recognizes the behavior of the demonstrator as goal-directed and (2) has some particular interest in or concern for replicating the precise technique performed by the author of the observed action.*

We articulate the latter claim in terms of the child's valuing reproducing the demonstrator's goal as an end-in-itself—although we remain open-minded about why children might have this end.

There are several ways that this definition can be filled out as empirical evidence becomes more conclusive. In the meantime, we have presented the basic structure and defining features of imitation. We take it that this theoretical exercise can help move us forward by specifying the kinds of empirical questions that we should ask and by suggesting a framework in which to ask them.

## Notes

- [1] For some recent and diverse reviews of this literature, see Moore (2013b); Nielsen, Subiaul, Galef, Zentall, and Whiten (2012); Over and Carpenter (2012); and Whiten (2011).
- [2] In this paper we address imitation as a mechanism for social learning. A parallel discussion of imitation has addressed not issues of skill acquisition, but questions of whether and to what extent the imitation-like tongue protrusions of neonate infants are indicative of a sense of self-awareness, and knowledge of the difference between self and other (Gallagher & Meltzoff, 1996; Lymer, 2012; Welsh, 2006). While we acknowledge the importance of these questions, we do not address them here.
- [3] In particular, this is something that Tomasello and colleagues have emphasized. See, for instance, Tennie et al. (2012).
- [4] We will follow Davidson (1963) and Dretske (1988) in taking an intentional action to be an action that is done for reasons. In the case of goal-directed actions, the reason is specified as the goal whereas for intentional actions, the reason is constituted by a desire or pro-attitude plus an instrumental belief.
- [5] See Byrne and Russon (1998), Moore (2013b), and Whiten et al. (2004) for more on these and related distinctions.
- [6] Not least, this was because Tomasello initially doubted that chimpanzees understand and attribute intentions. Later evidence changed his mind (Call, Carpenter, & Tomasello, 2005; Call & Tomasello, 2008).
- [7] Ultimately this is not something with which Tomasello's opponents in the imitation debate, not least Whiten and Heyes, need disagree. However, since they adopt a far broader conception of 'means' than does Tomasello, the distinction between emulation and imitation that Tomasello wants to defend become lost. One goal of this paper is to preserve that distinction through formulating a more precise conception of imitation.
- [8] On a related note, we reserve judgment on the question of whether the neonate behavior reported in Meltzoff and Moore (1977) is an instance of imitation, as we define it, or only a case of mimicry, or something else. While intentions to imitate may be present, evidence suggests that the infant's ability to reproduce accurately observed behaviors emerges only towards the end of its first year of life, and that neonate responses are limited to clumsily reproduced tongue protrusions. Since these responses are not matched to other forms of behavior, they may be only an indiscriminating arousal response to a variety of stimuli (Anisfeld, 1991, 1996, 2005; Maratos, 1982, 1998).
- [9] Some argue that such an account restricts imitation to the learning of visible muscle-movements, such that vocal imitation would not be possible (for example, Byrne, 2002; Heyes, 2001; Whiten & Ham, 1992). We think this restriction unmotivated: consistent with our everyday talk of imitation, the appeal to seen actions could, without loss, be replaced by an appeal to perceived properties.



- [10] We do not claim that non-human animals never imitate. See Moore (2013b) for a defense of the claim that chimpanzees may engage in limited vocal imitation. Our point here is only that imitation plays a privileged role in human development.
- [11] An action can be purposeful without being done for reasons. Intentional and goal-directed actions, as we understand them, are actions that are done for reasons.
- 885 [12] Note that we are not making any claims about the precise nature or format in which the recognition of an intention should be encoded or instantiated. We do not hold that the recognition of an intention must be conscious or explicit. And we are not committed to the claim that intentions for action could be recognized only in explicit language-like representations. Thus, the position we defend here is a minimal notion of ‘recognition’ which may be consistent with accounts of intentional action and intention recognition that are favored by theorists in embodied cognition traditions in the philosophy of mind. For work that discusses the authors’ commitments to the nature of cognition required for a range of skillful cognitive tasks, see Fridland (2013) and Moore (2013a).
- 890 [13] Determined in separate studies. See Horner and Whiten (2005) and Lyons et al. (2007) for similar results.
- 895 [14] For similar results, see Byrne and Russon (1998).
- [15] See Moore (2013a, 2013b) for further discussion.
- [16] See Nielsen et al. (2012) for a similar point.
- [17] See Moore, Liebal, and Tomasello (2013) and Moore (2014) for further discussion of the role of ostensive cues in children’s understanding of communicative intent.
- 900 [18] Gergely and Jacob (2012) themselves note this point.
- [19] In fact, in the same study, the role of ignorance was also tested. Adults professing ignorance of the actions required for the model task were still copied more faithfully than children who expressed knowledge of the task—although the difference was not significant. In the study of great apes, it is well documented that chimpanzees copy actions they have seen performed by older but not younger individuals (Biro et al., 2003; see also Moore, 2013b).
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