



Imitative flexibility and the development of cultural learning



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ABSTRACT

Two studies test the hypothesis that imitative fidelity is influenced by cues to interpret behavior as instrumental versus conventional. Study 1 ($N = 57$, 4–5-yr-olds) manipulated non-verbal cues (start- and end-states of action sequences) and Study 2 ($N = 211$, 4–6-yr-olds) manipulated verbal cues to examine the effects of information about instrumental versus conventional goals on imitative fidelity. Imitative fidelity was highest (Studies 1 and 2), innovation was lowest (Study 1), and difference detection was more accurate (Study 2) when cued with information about conventional rather than instrumental behavior. The results provide novel insight into the kinds of information children use to adjudicate between instrumental and conventional behavior.

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1. Introduction

The capacity to imitate others is integral to the development of human cultural learning (Gergely & Csibra, 2006; Legare & Watson-Jones, in press; Tomasello, Carpenter, Call, Behne, & Moll, 2005; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Imitation is a pervasive feature of children's behavior, yet to date there is not an integrated theoretical account of how children flexibly use imitation and innovation to drive cultural learning. To be effective and efficient learners, children must be selective about when to imitate, when to innovate, and to what degree. Here we examine the kinds of information children use to determine when an event provides an opportunity for learning instrumental skills and when it provides an opportunity for learning cultural conventions such as rituals.

We hypothesize that the process of learning instrumental skills versus cultural conventions is driven by interpreting behavior as *instrumental* versus *ritual* action. When interpreting behavior as an instrumental act, the physical-causal basis of an action is in principle knowable, even if it is currently unknown (as would be the case for novice learners). In contrast, when interpreting behavior as a ritual act, the rationale for interpreting an action is not in

principle knowable from the perspective of physical causality and instead is based on social conventionality. Here we define ritual as socially stipulated, causally opaque behavior. We propose that ritual is a socially-motivated subset of conventional behavior with affiliative functions. The key distinction between instrumental and ritual behavior is not merely the presence of causal opacity (i.e., a physical-causal rationale for the action is unavailable) but is based on the interpretation of causal opacity. What distinguishes instrumental from ritual practices often cannot be determined directly from the action alone (Humphrey & Laidlaw, 1994; Staal, 1990; Whitehouse, 2004), but requires interpretation by the learner based on relevant social cues and contextual information. For instance, the act of lighting a candle could be interpreted instrumentally (e.g., to find a lost object in the dark) or ritualistically (e.g., to commemorate an event or mourn a death). Where ambiguity in interpretation exists, learners may seek out cues to determine how to interpret the goal of the behavior. We propose that instrumental and ritual interpretations are best understood as overlapping continua; in practice, the difference in perspective is often a matter of relative degree rather than kind.

Whereas learning an instrumental skill allows for variability and innovation in methods of execution, learning rituals requires close conformity to the way other group members perform the actions (Herrmann, Legare, Harris, & Whitehouse, 2013; Watson-Jones, Legare, Whitehouse, & Clegg, 2014). Given that imitation is used to acquire instrumental skills as well as to engage in

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cultural conventions such as rituals, what kinds of information influence imitative fidelity? Here we examine cues to the presence of an instrumental versus a conventional goal, using nonverbal (Study 1) and verbal (Study 2) cues.

1.1. Instrumental imitation

Imitation has primarily been studied as a means of acquiring instrumental skills for manipulating the physical world through a process of social learning. Research on instrumentally motivated imitation examines children's search for physical-causal rationales for behavior (Gergely, Bekkering, & Kiraly, 2002; Gleissner, Meltzoff, & Bekkering, 2000; Nielsen & Tomaselli, 2010; Williamson & Markman, 2006; Woodward, 2009), a process with origins in early-developing beliefs about causal determinism (Gelman, 2003; Schulz & Sommerville, 2006) and goal hierarchies (Byrne & Russon, 1998). For example, although children are most likely to imitate an end-goal in an action sequence (Bekkering, Wohlschläger, & Gattis, 2000), when an end-goal is not available, an observer will imitate the means, presumably because reproducing the actions becomes the goal (Carpenter, Call, & Tomasello, 2005; Schachner & Carey, 2013). According to the principal of rationality in action, children use the most efficient means to reach a goal given knowledge of means, goals, constraints, and relevance (Buchsbaum, Gopnik, Griffiths, & Shafto, 2011; Gergely & Csibra, 2003; Gergely et al., 2002; Kiraly, Csibra, & Gergely, 2013).

In contrast, research on "overimitation" has shown that children will imitate obviously causally irrelevant aspects of an action sequence even when they are aware that the behavior is unnecessary to achieving an end-goal (Horner & Whiten, 2005; Kenward, Karlsson, & Persson, 2011; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen, 2006; Nielsen & Blank, 2011; Nielsen, Moore, & Mohameddally, 2012; Nielsen & Tomaselli, 2010; Over & Carpenter, 2009). An interest in understanding instrumental imitation is reflected in the experimental paradigms used to examine this process (e.g., tool use activities to retrieve rewards), priming a search for physical-causal rationales for behavior (e.g., puzzle boxes).

The emphasis on the instrumental aspects of imitation is historically linked to research agendas in comparative psychology (Call, Carpenter, & Tomasello, 2005; Call & Tomasello, 1995; Nagell, Olguin, & Tomasello, 1993; Tomasello, Savage-Rumbaugh, & Kruger, 1993; Whiten, Custance, Gomez, Teixidor, & Bard, 1996). Horner and Whiten (2005) have demonstrated that even when it is obvious that some actions are causally irrelevant in retrieving a reward from a puzzle box, children still faithfully copy all of the actions of a demonstrator, as compared to chimpanzees, who omit obviously irrelevant actions to retrieve the reward. According to these researchers, overimitation is an adaptive human strategy facilitating more rapid social learning of instrumental skills than would be possible if copying required a full representation of the causal structure of an event (Gergely & Csibra, 2006; Horner & Whiten, 2005; Nielsen, Tomaselli, Mushin, & Whiten, 2014; Wood, Kendal, & Flynn, 2013). The copying of unnecessary actions has also been interpreted as over-attribution of causal efficacy to redundant elements or automatic causal encoding (Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons, Young, & Keil, 2007).

Despite evidence that children are indeed instrumental imitators (Gergely et al., 2002; Want & Harris, 2002; Williamson, Meltzoff, & Markman, 2008), causal reasoning is not integral to all imitative behavior (Bird, Brindley, Leighton, & Heyes, 2007; de Waal & Ferrari, 2010; Heyes, 2009; Leighton, Bird, & Heyes, 2010). Beyond instrumental skills, children must also learn cultural conventions such as socially shared beliefs, values, norms, and

practices (Harris, 2012; Kashima, 2008; Legare, Evans, Rosengren, & Harris, 2012; Whitehouse, 2011).

1.2. Ritual imitation

High fidelity imitation has been linked to quintessentially social concerns (Uzgiris, 1981), such as encoding normative behavior (Kenward, 2012; Kenward et al., 2011), affiliation (Churchland, 2011; Kitayama & Cohen, 2007; Over & Carpenter, 2012; Preston & de Waal, 2002), shared experience (Tomasello et al., 2005), and fear of ostracism (Lakin, Chartrand, & Arkin, 2008; Over & Carpenter, 2009). Social accounts of overimitation have proposed that children engage in high fidelity imitation to demonstrate shared intentions with the actor (Over & Carpenter, 2012; Tomasello et al., 2005). Kenward et al. (2011) and more recently, Keupp, Behne, and Rakoczy (2013), have argued that children encode causally irrelevant actions not as causally efficacious in some way, or even to demonstrate shared intentions, but rather to conform to normative conventions.

Much of cultural learning is motivated by affiliative goals, resulting in the acquisition of conventional rather than instrumental behavior. A growing literature indicates that children's social learning is sensitive to relations among individuals (Chudek, Heller, Birch, & Henrich, 2012; Chudek & Henrich, 2011; Nielsen & Blank, 2011) and particularly to whether two or more individuals act or judge in the same way (Corriveau, Fusaro, & Harris, 2009; Corriveau & Harris, 2010). New research suggests that imitative fidelity is higher after witnessing multiple actors than single actors and higher after witnessing synchronous than successive actors, even among 3-year-olds (Herrmann et al., 2013).

Children conform to a group consensus in situations where no instrumental knowledge can be gained (Claidière & Whiten, 2012) and disguise their correct opinions to conform to a group consensus (Haun, Rekers, & Tomasello, 2012; Haun & Tomasello, 2011). Children are highly sensitive to the "proper" way to engage in conventional tasks such as games (Schmidt, Rakoczy, & Tomasello, 2011) and work to both recreate and enforce normative actions (Haun & Tomasello, 2011; Haun, van Leeuwen, & Edelson, 2013). Preschool children also protest when the rules of a novel game are broken (Rakoczy, Brosche, Warneken, & Tomasello, 2009; Rakoczy, Warneken, & Tomasello, 2008) or social role conventions are violated (Carter & Patterson, 1982; Levy, Taylor, & Gelman, 1995). Children have also been shown to conform to a group consensus in purely social situations, where no new instrumental knowledge can be gained (Schmidt et al., 2011). Children are more likely to engage in high fidelity imitation of an instrumental task when primed with ostracism (Over & Carpenter, 2009; Watson-Jones et al., 2014), suggesting that children's motivation to engage in high fidelity imitation may be inherently motivated by affiliating with social groups (Legare & Watson-Jones, *in press*; Over & Carpenter, 2012). Based on these early developing capacities, there is evidence for an early-developing "norm psychology" that supports reasoning about the conventionality of behavior (Chudek & Henrich, 2011; Chudek, Zhao, & Henrich, 2013), a prerequisite for ritual learning.

We propose that many of the rituals that children must learn to become competent members of their cultural communities are opaque from the perspective of physical causation and instrumental goals. In addition, many social conventions (e.g., forms of greeting such as handshaking, kissing, genuflection, bowing) do not entail changes to the physical state of the world in any observable fashion. Although often intended to have effects, rituals typically involve changes to social status (e.g., initiation rites) or to relationships with other people (e.g., weddings) and supernatural agents (e.g., sacrifices). If they are intended to have instrumental effects (e.g., magical rituals promoting crop fertility or healing the sick)

they are not expected to do so by physical-causal means that are transparent or even in principle knowable.

1.3. Current studies

Cultural conventions, such as rituals, customs, and etiquette, are group-specific, socially shared actions (Durkheim, 1915; Gluckman, 1954; Henrich, 2009; Rappaport, 1999; Turner, 1969; Whitehouse, 2012) that resist interpretation from a physical-causal perspective (Humphrey & Laidlaw, 1994), and involve imitating behavior for which physical-causal rationales are never provided and never sought (Legare & Herrmann, 2013; Legare & Souza, 2012, 2014; Whitehouse, 2011). We propose that start- and end-state equivalency of an action sequence prompts the interpretation that the observed actions are unknowable from a physical-causal perspective and thus, conventional. Because conventions are socially motivated, there is no better or more correct way to reproduce them than exactly the way they were demonstrated. In contrast, when actions result in a distinct end-state, the action sequence is interpreted as having an instrumental goal and a potentially knowable causal structure.

In Study 1, we test the hypothesis that when end-states are indistinguishable from start-states, inferences about an instrumental goal are inhibited, thereby increasing imitative fidelity and decreasing innovation (Watson-Jones et al., 2014). In contrast, when start-states and end-states are distinguishable, this primes expectations of a potentially knowable physical-causal structure, thereby decreasing imitative fidelity and increasing innovation. Unlike previous studies of overimitation that have used instrumental imitation tasks involving salient end-goals (i.e., puzzle boxes), our aim was to create an experimental design capable of assessing differences in imitative fidelity for action sequences with equivalent versus different start- and end-states.

In Study 2, our first objective was to examine the hypothesis that language cuing the presence of a social conventional, rather than an instrumental goal, produces greater imitative fidelity (Herrmann et al., 2013). There is growing evidence that even infants are sensitive to language cues to conventionality (Scott & Henderson, 2013) and new work suggests that preschoolers engage in flexible linguistic imitation (Bannard, Klinger, & Tomasello, 2013). Given evidence that children are sensitive to contextual variation in social information (Kavanagh, Suhler, Churchland, & Winkelman, 2011; Mesoudi, 2009; Rakoczy et al., 2009; Schmidt, Rakoczy, & Tomasello, 2012; Schmidt et al., 2011), two kinds of conventional verbal cues were used; a conventional-consistent cue (i.e., “this is how she always does it”) and a conventional-collective cue (i.e., “this is how we do it”) to examine different aspects of social conventionality. Two kinds of instrumental verbal cues were also used; an instrumental-goal cue (i.e., “she puts it in the box”) and an instrumental-process cue (i.e., “she moves blocks”) to examine the effects of highlighting different aspects of an instrumental action sequence on imitative fidelity. An imitation task was used to examine differences in imitative fidelity when identical action sequences were prefaced with instrumental versus conventional verbal cues. We predicted higher imitative fidelity following the use of the conventional (consistent and collective) cues than the instrumental (goal and process) cues.

Our second objective in Study 2 was to provide support from a converging measure that cues to conventionality increase expectations for conformity and attention to behavioral variation. A difference detection task was used to examine children’s ability to identify variations between two actors performing similar action sequences. We predicted that children’s accuracy for detecting differences between performances of two actors would be greater when an action is interpreted as a social convention given greater expectations for conformity.

To examine developmental differences in sensitivity to instrumental versus conventional information in guiding imitative fidelity, 4–6-year-old children participated in Study 2. One possibility is that behavioral differences between imitating instrumental and conventional behavior increase with age and experience. Such differences might be attributable to socialization and the timing of cultural inputs, for instance, via formal education. Another possibility is that because an understanding of conventionality is early developing (Rakoczy et al., 2009; Scott & Henderson, 2013; Yu & Kushnir, 2013), variation in imitative fidelity is detectable even among 3-year-olds. In line with previous research on age differences in overimitation (Herrmann et al., 2013; Lyons et al., 2007; McGuigan et al., 2007; Nielsen & Tomaselli, 2010), we predicted that older children would be more sensitive to cues to instrumentality versus conventionality than younger children, a finding that may be due to increasing understanding of social conventionality with age.

2. Study 1

The objective of Study 1 was to examine young children’s imitative and innovative behavior following observation of a causally opaque action sequence with equivalent start- and end-states to prime a conventional goal or different start- and end-states to prime an instrumental goal. This work builds upon recently published research demonstrating that start- and end-state equivalency increases imitative fidelity and thus may cue inferences about conventional behavior (Watson-Jones et al., 2014). Children’s behavior was analyzed following two between-subjects conditions, in which the relationship between the end- and start-states of an action sequence was manipulated to vary the attribution of an instrumental versus a social conventional goal. In the conventional condition, the modeled action sequence ended just as it began – there was no distinct end-state and thus no instrumental goal. In the instrumental condition, the actions were the same as in the conventional condition except that at the conclusion of the action sequence a new object was introduced and used in an instrumental way, thereby creating an end-state that differed from the start-state and priming an inference about a physical-causal goal (i.e., opening a box in order to place an object inside of it). We predicted greater imitative fidelity in the conventional than in the instrumental condition, and conversely less innovation in the conventional than in the instrumental condition.

2.1. Methods

2.1.1. Participants

Fifty-seven children (31 females; *M* age 4;8; range 4,0 to 5,6) were recruited from a university town in the American southwest. Participants were primarily Euro-American and from middle-class families. Data from 7 additional participants were dropped due to experimenter error.

2.1.2. Materials

A set of novel objects was designed in order to demonstrate object manipulation in videotaped novel action sequences that were 40 s in length. In the conventional condition, the stimuli included a blue cube, orange sphere, purple chess piece, black peg-board (with three colored pegs: yellow, red, and blue), grey tray, and silver box. The stimuli in the instrumental condition were identical to the conventional condition except for the addition of a green pipe. A laptop and a display screen were used for presenting video stimuli.

2.1.3. Design and procedure

2.1.3.1. Imitation task. In each of two between-subjects conditions, participants engaged in an object manipulation task. The objective was to examine how a distinct versus equivalent start- and end-state of a modeled action sequence influenced children's imitative and innovative behavior.

The experimenter presented the child with a display screen connected to a laptop where the experimenter controlled a video. Children watched a single presentation of a videotaped action sequence in one of the between-subjects conditions (conventional or instrumental). Prior work has demonstrated that copying fidelity is lower following video demonstrations than live demonstrations (Barr & Hayne, 1999; Hayne, Herbert, & Simcock, 2003; McGuigan et al., 2007; Nielsen, Simcock, & Jenkins, 2008). Using video demonstrations presents a more conservative picture of imitative behavior and maximizes consistency in the presentation of the experimental stimuli across participants. Across conditions, children watched a video of an actor performing a novel action sequence with objects (see Fig. 1).

The experimenter told each participant, "This is my friend. She has something interesting she wants to show you, so let's watch very carefully." Her hands were placed flat on the table and the camera zoomed in to focus on her hands and a configuration of objects arranged in a linear order from left to right (i.e., the blue cube, orange sphere, purple chess piece, black pegboard, and silver box).

First, the demonstrator picked up the blue cube with her left hand and moved it above the yellow peg on the pegboard. She tapped the blue cube on the yellow peg twice and then placed the blue cube back in its original position on the table. Then she placed her hands flat on the table. Next she engaged in a novel gesture: she lifted her hands and pressed her fists together before placing her hands flat on the table. She then picked up the orange sphere with her left hand and moved it above the red peg on the pegboard. She tapped the red peg with the orange sphere twice and then placed the orange sphere back in its original position on the table. She repeated the novel gesture by placing her hands back on the table, pressing her fists together, and placing her hands flat on the table. At this point the action sequence in each condition differed in the kind of end-state modeled. The sequences were designed to include primarily arbitrary but intentional actions across conditions (Barr & Hayne, 1996). Due to the intentional nature of the behavior we argue that the actions done within the demonstration were unlikely to be interpreted as meaningless, even if the meaning of the act is unknown.

In the conventional condition, the demonstrator picked up the purple chess piece with her left hand and used it to slide the box lid open. She then closed the box with her right hand. She placed the purple chess piece back in its original position on the table (Fig. 1). In the instrumental condition, the action sequence was identical to the conventional condition except that it included an embedded enabling sequence. Instead of opening the box with the purple chess piece, a previously occluded green pipe was moved into view and used to slide open the box. The green pipe was then placed inside with the left hand, and as in the other conditions, the box was closed with the right hand. To maintain causal opacity while increasing attributions of a physical-causal end-goal, the green pipe was only included in the instrumental condition (Fig. 1). In both conditions, the video ended with the demonstrator's hands flat on the table. Whereas most of the behavior demonstrated in each condition may be described as causally opaque, only in the conventional condition were the end-state and start-state identical. As such, we would not anticipate that children in this condition would attribute an instrumental goal to the task. By contrast, because end-states and start-states differed in the instrumental condition, the procedure had a discernible and

distinct outcome that could be interpreted as an instrumental goal (Fig. 1).¹

At the conclusion of the video, the screen was turned off and the objects that the child had seen in the video were placed back into view of the child, arranged in the same configuration from the child's perspective. The experimenter told the child, "See these objects here? Now it's your turn." The objects were then placed within reach of the child and the participant was told, "Here you go." Participants were not given any explicit instruction to imitate the actions seen in the video. The child was given 60 s to interact with the objects before the objects were moved from within reach of the child but kept within view. Pilot data indicated that children did not regularly interact with the objects for more than 60 s.

2.1.4. Coding

2.1.4.1. Imitation task. Children's interactions with the objects were video recorded and transcribed. Study transcripts were analyzed for the types of imitative and innovative actions in which children engaged.

2.1.4.1.1. Imitative fidelity. Imitative behavior was coded for six dependent variables. An overall imitation summary score (0–6) was created by combining key components of imitative fidelity. The variables coded for were correct action-object pairing, (i.e., if the blue cube and the orange sphere were exclusively used to tap on the pegs, they received a score of 1, if they did not do either of these things, they received a score of 0; tapping an object twice on a peg, 0–1), accuracy of sequencing (i.e., blue cube used, followed by the orange sphere, and then the purple chess piece or green pipe, 0–1), and accuracy of box-oriented actions (i.e., engaged with the box at the end of the action sequence, 0–1; used an object to open the box, 0–1; did not insert an object into the box in the conventional condition and correctly inserted an object into the box in the instrumental condition, 0–1). Due to low levels of reproduction of modeled gestures (occurred in 2% of children), gesture was not included in the imitation summary score.

2.1.4.1.2. Innovation. Innovation is defined as variations on previously modeled behavior as well as novel behavior (i.e., not previously modeled). All deviations from the observed sequence were recorded and the most frequently performed actions across conditions were used to calculate a summary score for innovative behavior. We chose these actions because they were by far the highest frequency behaviors. Behavioral deviations from the observed sequence included tapping the purple piece on a peg (occurred with 37% of children), inserting object onto peg (32%), opening the box with a hand (occurred with 25% of children), stacking objects on top of each other (21%), balancing objects on a peg (21%), engaging with the box at the beginning of the action sequence (23%), inserting objects into one another (7%), and other (9%). The innovation summary score (0–6) was calculated using the six most frequent variables. For each of the following behaviors, children received a 1 if they engaged in them and 0 if they did not: tapping the purple piece on a peg, inserting objects onto peg, opening box with hand, stacking objects on top of each other, balancing objects on a peg, engaging with the box at the beginning of the action sequence.

Inter-rater reliability was established using a randomly selected sample of 25% of the target behaviors for the imitation and

¹ A pilot control condition was conducted that included the same objects as in the conventional condition and the same end-state as the instrumental condition. The final action sequence was identical to the conventional condition, except for the manipulation of the purple chess piece. After sliding the box lid open with the purple chess piece using her left hand, rather than returning the object to its original location (as in the conventional condition) the demonstrator placed the purple chess piece inside the box and closed the box with her right hand (as in the instrumental condition). The results were not statistically different from the results of the instrumental condition.

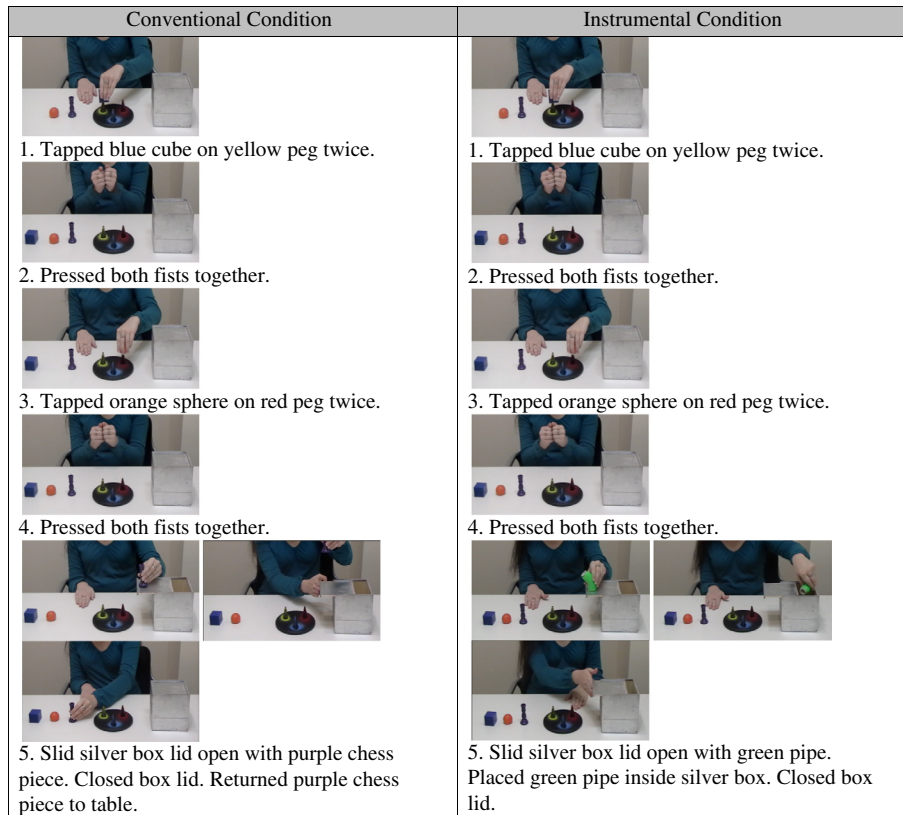


Fig. 1. Action sequences modeled in the conventional and instrumental conditions.

innovation summary score. Two persons independently coded the reliability sample for the target behaviors with 86% agreement, Cohen's Kappa = .83. This Kappa indicates almost perfect agreement (.81 and above) (Landis & Koch, 1977). Disagreements were resolved through discussion.

2.2. Results

2.2.1. Imitation task

We predicted that there would be higher levels of imitation in the conventional than in the instrumental condition. Conversely, we predicted that there would be greater innovation in the instrumental than in the conventional condition.

2.2.1.1. Imitative fidelity. As predicted, children engaged in higher levels of imitative behavior in the conventional condition than the instrumental condition. An Independent Samples *t*-test with condition as the independent variable and imitation summary score as the dependent variable revealed children in the conventional condition had higher imitation summary scores ($M = 3.50$, $SD = 1.64$) than children in the instrumental condition ($M = 2.03$, $SD = 1.82$), $t(54.76) = 3.19$, $p = .002$, 95% CI of mean difference [0.54, 2.39], $d = 0.85$.

2.2.1.2. Innovation. As predicted, children engaged in relatively higher levels of innovative behavior in the instrumental condition than the conventional condition. An Independent Samples *t*-test with condition as the independent variable and innovation summary score as the dependent variable revealed children in the instrumental condition had higher innovation summary scores ($M = 2.27$, $SD = 1.46$) than children in the conventional condition ($M = 0.86$, $SD = 1.11$), $t(52.20) = -4.11$, $p < .001$, 95% CI of mean difference [-2.11, -0.72], $d = 1.09$.

2.3. Discussion

Our data support our predictions that start- and end-state equivalence increases imitative fidelity and that different start- and end-states decrease imitative fidelity. Children imitated with greater fidelity and engaged in less innovative behavior in the conventional than in the instrumental condition. Our results add to growing evidence that children use non-verbal cues to interpret behavior as instrumental versus conventional (Watson-Jones et al., 2014). For example, there is evidence that consensus (i.e., identical behavior from multiple actors) and synchrony (i.e., multiple actors engaging in simultaneous, identical behavior) also increase imitative fidelity and may be cues to conventional behavior (Herrmann et al., 2013).

Although our data are consistent with our proposal, and provide evidence that children can interpret the conventional nature of a task from an action sequence, there are other (complementary) interpretations of our results. Another possible interpretation of our data is that children imitate more precisely when they are unsure about the goal of an action sequence. Past research has found that the presence or absence of a salient end-goal of an action sequence influences imitative fidelity of behavioral means versus ends to the means (Bekkering et al., 2000; Byrne & Russon, 1998; Carpenter et al., 2005; Schachner & Carey, 2013; Williamson & Markman, 2006).

Our objective in Study 1 was to manipulate start- and end-state equivalency versus difference to vary (relative) causal opacity (which we acknowledge is often correlated with goal opacity). In the instrumental condition, an additional object was included as part of the final end-state action, and thus the inclusion of this object may have increased the transparency of the goal of the action sequence (to put the object in the box). We included an additional object (placed inside the box) to increase both the transparency of the goal and the interpretation of the prior portion of the action sequence as causally opaque. Pilot data with a control

condition in which the same object used in the ritual condition was used in the end-state (inserted into the box) indicated that there was no significant difference between this action sequence and the instrumental condition¹, yet further research is needed to examine the relationship between causal opacity, goal opacity, and start- and end-state equivalency versus difference and their relative impact on imitative fidelity.

We acknowledge that goal opacity may indeed increase imitative fidelity (Schachner & Carey, 2013). Yet there is also evidence from research on overimitation that children will imitate intentional but causally-irrelevant actions with high fidelity, even when told explicitly (and repeatedly) what the (instrumental) goal is (Lyons et al., 2007). Thus the transparency of the goal alone cannot explain lower fidelity imitation. We argue that the kind of goal impacts imitative fidelity. For example, children imitate behavior with instrumental goals with less fidelity than behavior with conventional goals (Herrmann et al., 2013; Nielsen, Kapitány, & Elkins, 2015; Watson-Jones et al., 2014).

By design, both causal and goal opacity were high across conditions in Study 1. To further examine the impact of information about the goal of behavior, in Study 2, we used verbal cues to decrease goal ambiguity and opacity. We predict that in addition to nonverbal cues such as start- and end-state equivalence, verbal cues also influence imitative fidelity. Recent research has demonstrated that conventional language increases imitative fidelity (Herrmann et al., 2013). One of the advantages of using verbal cues in Study 2 is that the action sequences are identical across conditions and thus any differences in imitative fidelity across conditions can be attributed to inferences about the goal of the action sequence. This feature of the design of Study 2 allowed us to disambiguate causal and goal opacity. In Study 2, we examine the effects of conventional and instrumental language on imitative fidelity as well as the impact of these cues on the capacity to detect differences between the performances of two actors, trends that we predicted increase with age.

3. Study 2

The first objective of Study 2 was to examine the effect of conventional versus instrumental language on imitative and innovative behavior. Preschool children are sensitive to language as a cue for interpreting conventional behavior (Herrmann et al., 2013; Scott & Henderson, 2013) and use generic, normative language to enforce social norms (Schmidt & Tomasello, 2012). Four kinds of verbal cues were used (two were conventional and two were instrumental). In the conventional-consistent condition, we indicated that the modeled behavior had recurrently consistent features (i.e., “this is how she always does it”). In the conventional-collective condition, we indicated that the modeled behavior had recurrent features specific to a collective group (i.e., “this is how we do it”). In the instrumental-goal condition, we indicated that the modeled behavior had a salient instrumental end goal (i.e., “she puts it in the box”). In the instrumental-process condition, we provided information about the process of the action sequence (i.e., “she moves blocks”).² Notably, unlike Study 1, the

² We considered the possibility that using a verbal cue that refers to the end-state rather than all of the actions would reduce attention to the action sequence which might result in lower levels of imitative fidelity. In previous work we examined this possibility explicitly by testing an instrumental verbal cue that refers to the actions. In a novel experimental task involving a series of peg tapping actions, the instrumental cue (i.e., “she gets the pegs up”) refers explicitly to a series of actions, rather than the final action (Herrmann et al., 2013). The conventional cue was identical to the conventional-consistent cue used in this study (i.e., “she always does it that way”). The data from this paper demonstrate significantly lower rates of imitative fidelity for the instrumental cue than the conventional cue, consistent with the data we report in this paper, and consistent with our theoretical interpretation.

novel action sequences in Study 2 were identical across conditions. We predicted greater imitative fidelity in the conventional conditions than in the instrumental conditions, a trend that increases with age.

The second objective was to test the hypothesis that the use of conventional language increases sensitivity to differences between the performances of two actors. We hypothesized that the social conventionality of an action triggers affiliative behavior through conformity, thus motivating greater attention to procedural detail and identification of deviations. We predicted that there would be greater accuracy in difference detection in the conventional conditions than in the instrumental conditions, trends that increase with age.

3.1. Methods

3.1.1. Participants

One-hundred and five younger children (66 females; *M* age 4,8; range 4,0 to 5,3) and 106 older children (56 females; *M* age 6,1; range 5,4 to 6,11) were recruited from a university town in the American southwest. To examine age-related changes, data analyses were done by age group (younger versus older). Participants were primarily Euro-American and from middle-class families. Only 172 participants completed both the difference detection and imitation tasks. Data from additional participants (16 4-year-olds, 3 5-year-olds, 4 6-year-olds) were dropped due to failure to meet inclusion criteria (i.e., failure to complete the training task or failure to complete the difference detection task).

3.1.2. Materials

In each of four between-subjects conditions, children participated in a training task in which they were presented with images of colored shapes. The shapes included a yellow star, blue flower, pink flower, green triangle, yellow heart, and red hexagon. The stimuli for the difference detection and imitation tasks included a blue cube, orange sphere, purple chess piece, green pipe, red pipe, wooden pegboard (with three colored pegs: green, red, and yellow), silver tray, and silver box. A laptop and a display screen were used for presenting training task images and video stimuli in the difference detection task.

3.1.3. Design and procedure

In each of four between-subjects conditions, participants engaged in two tasks: the difference detection task and the imitation task. In the difference detection task, children were shown two variants of an action sequence, and were asked to identify the similarities and differences between them. In the imitation task, children were presented with the objects they had seen in the previous videos and allowed to interact with them.

3.1.3.1. Difference detection task. Children participated in a training task to familiarize them with the video screen and paradigm used in the difference detection task. The experimenter presented the child with a display screen connected to a laptop where the experimenter controlled a Powerpoint presentation. Children were then shown 6 sequential pictures of objects, 3 of which contained a yellow star. Children were asked to respond yes or no in each trial if there was the presence of a yellow star. The experimenter said, “We are going to play a game with some pictures of objects. I need your help finding the yellow stars. I am going to show you some pictures and then ask you if you see a yellow star in them. If you see a yellow star, say ‘yes’. If you do not see a yellow star, say ‘no.’”

Following the training task, children participated in a difference detection task (Fig. 2). First, children watched a 45 s video of a female actor interacting with objects in four between-subjects conditions (conventional-consistent, conventional-collective, instrumental-



Fig. 2. Action sequences modeled across conditions by Actor 1 and Actor 2. *Difference between the sequences modeled by Actor 1 and Actor 2.

goal, or instrumental-process). In the conventional-consistent condition, the experimenter presented the video saying, “I’m going to show you my friend Anna. She always does it this way. Let’s watch very carefully. She always does it this way.” In the conventional-collective condition, the experimenter presented the video saying, “I’m going to show you my friend Anna. This is how we do it. Let’s watch very carefully. This is how we do it.” In the instrumental-goal condition, the experimenter presented the video saying, “I’m going to show you my friend Anna. She puts it in the box. Let’s watch very carefully. She puts it in the box.” In the instrumental-process condition, the experimenter presented the video saying, “I’m going to show you my friend Anna. She moves blocks. Let’s watch very carefully. She moves blocks.”

Across conditions, children watched a video of an actor performing a novel action sequence with objects. The action sequence contained six distinct action segments: tapping the blue cube, first novel hand gesture, tapping the orange sphere, second novel hand gesture, tilting the box, and inserting an object into the box. Following the first video, the experimenter introduced a second video, which contained variation from the original video presented. The videos were counterbalanced for order and the first video was always presented as a whole video, whereas the second video was presented in six discrete clips (ranging from 3 to 12 s in length), corresponding to the distinct action segments seen in the first video (Fig. 2). In the conventional-consistent condition, the experimenter said, “Next, I’m going to show you a few videos of my

friend Kelly. This is how she always does it. We need your help finding out what she does differently in these videos from my friend Anna that we just saw, okay? I’m going to ask you if what you see her doing is the same as or different from what my friend Anna did in the first video. Will you tell us if it’s the same or different? Okay! Let’s watch very carefully. This is how she always does it.” In the conventional-collective condition, the experimenter said the same words, except instead of “This is how she always does it”, the experimenter said “This is how we do it”, in the instrumental-goal condition, the experimenter said “She puts it in the box”, and in the instrumental-process condition, the experimenter said “She moves blocks.” After each of the clips in the second video were played, the experimenter asked “Was that different or the same as what Anna did?” the child responded, and then the experimenter prompted, “Let’s keep watching!”

3.1.3.1.1. Coding. Children’s responses to “Was that the same or different as what Anna did?” were recorded. For each action (6: blue cube, first gesture, orange sphere, second gesture, box tilt, object insertion), children received a score of 1 if they correctly identified whether it was same or different and a 0 if they incorrectly identified whether it was the same or different. Children’s performance on the six individual action segments was averaged into a single proportion correct score, referred to below as accuracy.

3.1.3.2. Imitation task. At the conclusion of the video, the screen was turned off and the monitor was removed from the table. The objects that the child had seen in the video were placed in view of the child, arranged in the same configuration as in the video from the child's perspective. The experimenter told the child, "See these objects here? Now it's your turn." The objects were then placed within reach of the child and the child was told, "Here you go." Participants were not given any explicit instruction to imitate the actions seen in the video. The child was given 60 s to interact with the objects before the objects were moved from within reach of the child, but kept within view.

3.1.3.2.1. Coding. Children's interactions with the objects were video recorded and transcribed. Study transcripts were analyzed for imitative fidelity across both action sequences. Because children saw more than one action sequence during the difference detection task in Study 2, innovative behavior occurred at very low levels overall and thus was not included in the analyses.

3.1.3.2.2. Imitative fidelity. Children's behavior was coded for their reproduction of novel actions modeled in both videos. Imitative behavior was coded for five dependent variables. An overall imitation summary score (0–5) was created by combining key components of imitative fidelity. The variables coded for were accuracy in engaging in tapping action (i.e., object contact with pegs, 0–1; object tapped twice on a peg, 0–1), accuracy of sequencing (i.e., used the blue cube, followed by the orange sphere, and then the red pipe or green pipe, 0–1), and accuracy of box-oriented actions (i.e., opened box with object, 0–1; tilted box, 0–1). Due to low levels of reproduction of modeled gestures, gesture was not included in the imitation summary score (hand gestured occurred with 8% of children).

Inter-rater reliability was established using a randomly selected sample of 25% of the target behaviors for the imitation and innovation summary scores. Two persons independently coded the reliability sample for the target behaviors with 92% agreement, Cohen's Kappa = .90. This Kappa indicates almost perfect agreement (.81 and above) (Landis & Koch, 1977). Disagreements were resolved through discussion.

3.2. Results

3.2.1. Difference detection task

We did not have any a priori predictions that there would be any differences in children's accuracy in the difference detection task between the two conventional conditions (consistent and collective). We did not have a-priori predictions that there would be any differences in children's accuracy in the difference detection task between the two instrumental conditions (goal and process). We ran Independent Samples *t*-tests with condition as the independent variable and accuracy as the dependent variable to verify that there were no differences between both conventional conditions and between both instrumental conditions. As predicted, children in the conventional-consistent condition did not significantly differ ($M = .78$, $SD = 0.19$) from children in the conventional-collective condition ($M = .78$, $SD = 0.17$), $t(105) = 0.03$, $p = .979$. Children in the instrumental-goal condition did not significantly differ ($M = .66$, $SD = 0.22$) from children in the instrumental-process condition ($M = .68$, $SD = 0.19$, $t(102) = -0.40$, $p = .688$). Thus, we combined the participants from both conventional conditions and combined the participants from both instrumental conditions in our analyses.

Children's accuracy in the difference detection task was analyzed using parametric tests. An ANOVA with accuracy as the dependent measure and age group (2: younger and older) and condition (2: instrumental and conventional) as between subjects factors revealed main effects of condition, $F(1,207) = 18.48$, $p < .001$, partial $\eta^2 = .08$, and age group, $F(1,207) = 11.32$, $p = .001$, partial

Table 1

Children's mean accuracy in the difference detection task by type of action and condition.

Age group	Action segments	Condition	
		Conventional	Instrumental
Younger	Pegs tap ^a	.79 (0.32)	.63 (0.34)
	Gesture ^a	.69 (0.33)	.61 (0.32)
	Box tilt	.74 (0.45)	.77 (0.43)
	Box insertion	.74 (0.45)	.54 (0.50)
Older	Pegs tap ^a	.91 (0.20)	.71 (0.29)
	Gesture ^a	.82 (0.24)	.78 (0.30)
	Box tilt	.94 (0.23)	.79 (0.41)
	Box insertion	.57 (0.50)	.52 (0.50)

^a Action category is an average of two action segments. Standard deviations are in parentheses.

$\eta^2 = .05$. Overall, children in the instrumental conditions ($M = .67$, $SD = 0.20$) were less accurate at detecting differences than children in the conventional conditions ($M = .78$, $SD = 0.18$). Younger children ($M = .68$, $SD = 0.21$) were less accurate at detecting differences than older children ($M = .77$, $SD = 0.19$). There was no significant interaction between condition and age group, $F(1,207) = 0.001$, $p = .975$.

We also analyzed children's accuracy at detecting differences and similarities for each specific action segment of the action sequences (4: the average of the two peg tapping actions, the average of the two gestures, the box tilting action, and the box insertion action). See Table 1.

3.2.2. Imitation task

3.2.2.1. Imitative fidelity. We did not have any a priori predictions that there would be any differences in children's imitative fidelity between the two conventional conditions (consistent and collective). We also did not have any a priori predictions that there would be differences in children's imitative fidelity between the two instrumental conditions (goal and process). We ran Independent Samples *t*-tests with condition as the independent variable and imitation summary score as the dependent variable to verify that there were no differences between both conventional conditions and between both instrumental conditions. Children in the conventional-consistent condition did not significantly differ ($M = 2.65$, $SD = 1.03$) from children in the conventional-collective condition ($M = 2.59$, $SD = 0.91$), $t(84) = -.302$, $p = .763$. Children in the instrumental-goal condition did not significantly differ ($M = 2.13$, $SD = 0.94$) from children in the instrumental-process condition ($M = 2.39$, $SD = 0.99$), $t(84) = -1.23$, $p = .223$. Thus, we combined the participants from both conventional conditions and combined the participants from both instrumental conditions in the analyses.

Children's imitative fidelity between the combined conventional and combined instrumental conditions was analyzed with parametric tests. An ANOVA with the imitation summary score as a dependent measure and age group (2: younger and older) and condition (2: instrumental and conventional) as between-subjects factors was conducted. There was a main effect of condition, $F(1,168) = 5.76$, $p = .018$, partial $\eta^2 = .03$ and age group, $F(1,168) = 13.86$, $p < .001$, partial $\eta^2 = .09$. Overall, children in the instrumental conditions had lower imitation summary scores ($M = 2.26$, $SD = 0.97$) than children in the conventional conditions ($M = 2.62$, $SD = 0.96$). Younger children had lower imitation summary scores ($M = 2.16$, $SD = 0.94$) than older children ($M = 2.73$, $SD = 0.79$). There was no significant interaction between condition and age group, $F(1,168) = 0.585$, $p = .445$.

3.2.3. Correlation across measures

A Pearson product-moment correlation coefficient was computed to assess the relationship between difference detection

scores and imitation summary scores. There was a significant positive correlation between difference detection scores and imitation summary scores, $r(171) = .151$, $p = .048$, 95% CI [.001, .294].

3.3. Discussion

We propose that social conventions such as rituals cue expectations of affiliation through conformity, thus motivating higher imitative fidelity, greater attention to procedural detail and identification of deviations. Our data provide evidence that language cuing conventional versus instrumental goals differentially influences accuracy in difference detection and imitative fidelity. Children's imitative fidelity and rates of accurate difference detection were higher in the conventional conditions than in the instrumental conditions. Imitative fidelity was positively correlated with accuracy in difference detection. We also found evidence that as children age, imitative fidelity increases and they become more skilled at identifying differences and similarities in the performances of different actors across conditions.

Given evidence that children are sensitive to contextual variation in social information (Kavanagh et al., 2011; Mesoudi, 2009; Rakoczy et al., 2009; Schmidt et al., 2011, 2012), we used a variety of conventional and instrumental cues. To examine different aspects of social conventionality, we included cues to consistency and collectivity, expanding upon previous research that only used cues to consistency (Herrmann et al., 2013). To examine the effects of highlighting different aspects of an instrumental action sequence, we included cues to both outcome and process, to expand upon previous research that only used cues to outcome (Herrmann et al., 2013).

One of the advantages of using verbal cues in Study 2 is that the action sequences are identical across conditions and thus any differences in imitative fidelity across conditions can be attributed to inferences about the goal of the action sequence. We used instrumental and conventional language in Study 2 to increase goal transparency across conditions. This feature of the design of Study 2 allowed us to disambiguate casual and goal opacity and to examine the impact of conventional versus instrumental goals on imitative fidelity and accuracy of difference detection. Our data are consistent with recent research demonstrating that conventional language increases imitative fidelity to a greater extent than instrumental language (Herrmann et al., 2013). Study 2 adds to growing evidence that inferences about conventional versus instrumental goals are associated with distinct behavioral profiles, including differences in imitative fidelity as well the capacity to detect differences between the performances of two actors.

4. General discussion

Despite the fact that imitation is a pervasive feature of children's behavior (Kurzban & Barrett, 2012; Meltzoff & Williamson, 2010; Nielsen & Tomaselli, 2010; Tomasello et al., 2005; Want & Harris, 2002), the current research provides the first integrated theoretical account of how children use imitation flexibly to adjudicate between instrumental and conventional behavior. We hypothesize that the psychological systems supporting learning instrumental skills versus learning cultural conventions are driven by interpreting behavior as instrumental versus conventional.

We propose that the demands of instrumental and ritual learning are different in a number of key respects. In instrumental learning, the learner attends closely to instrumental goals but in the learning of social conventions such as rituals, attention turns more closely to the manner in which things are done. Discerning which aspects of a novel action sequence matter cannot be inferred from their physical-causal consequences and so the learner must take

note of all intentional aspects of a modeled performance, maximizing attention to detail and increasing the fidelity of subsequent imitation.

In two studies, we examined the kinds of information children use to determine when an event provides an opportunity for high fidelity imitation versus innovation and how these processes may support learning both instrumental skills and cultural conventions. The conditional differences in behavioral patterns were robust across studies using both nonverbal (Study 1) and verbal (Study 2) cues. Our data support our prediction that imitative fidelity is higher (Study 1 and 2) and innovation is lower (Study 1) when behavior is interpreted as conventional rather than instrumental. Children in Study 2 also showed greater accuracy in detecting differences between action sequences in the conventional conditions than in the instrumental conditions. There is also evidence for convergence across measures of conformity, as imitative fidelity and difference detection were positively correlated. Study 2 revealed that imitative fidelity and ability to detect deviations in modeled behavior increased with age, suggesting that sensitivity to social conventionality increases with development. The social pressure to conform in ever more subtle ways intensifies with age (Yu & Kushnir, 2013), which may account for the developmental trajectory observed in the current studies.

We propose that start- and end-state equivalence and language are two of many kinds of cues to the instrumentality versus conventionality of actions that differentially influence imitative fidelity and innovation in early childhood. In recent work, we have examined other kinds of information that influence imitative fidelity such as information about the reliability of the informant, how representative and conventional the behavior is at the level of the group, social consensus, and perceptions of ostracism (Herrmann et al., 2013; Watson-Jones et al., 2014).

To be effective and efficient cultural learners, children must be selective about when to imitate, when to innovate, and to what degree. These studies provide new insight into the kinds of information children use to determine when an event provides an opportunity for high fidelity imitation versus innovation and how these processes may support learning both instrumental skills and cultural conventions.

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