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The role of social interaction and pedagogical cues for eliciting and reducing overimitation in preschoolers

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ABSTRACT

The tendency to imitate causally irrelevant actions is termed overimitation. Here we investigated (a) whether communication of a model performing irrelevant actions is necessary to elicit overimitation in preschoolers and (b) whether communication of another model performing an efficient action modulates the subsequent reduction of overimitation. In the study, 5-year-olds imitated irrelevant actions both when they were modeled by a communicative and pedagogical experimenter and when they were modeled by a non-communicative and non-pedagogical experimenter. However, children stopped using the previously learned irrelevant actions only when they were subsequently shown the more efficient way to achieve the goal by a pedagogical experimenter. Thus, communication leads preschoolers to adapt their imitative behavior but does not seem to affect overimitation in the first place. Results are discussed with regard to the importance of communication for the transmission of cultural knowledge during development.

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Introduction

Imitation is a powerful mechanism that allows humans to learn novel actions from others (Meltzoff, 1988). In contrast to emulation, which is accomplished by copying the end state of an action without performing the observed action steps, imitation entails copying the action sequence itself (Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Although in many situations imitation is a quick and efficient learning tool, in other situations copying the exact actions observed in others is quite inefficient. For instance, in a study by Horner and Whiten (2005), the experimenter performed relevant actions as well as irrelevant actions while demonstrating how to retrieve a reward from a puzzle box to wild-born chimpanzees. When the box was opaque, chimpanzees imitated both kinds of actions. When the box was transparent, thereby revealing that irrelevant actions had no effect, chimpanzees employed a more efficient strategy of emulation and omitted the irrelevant actions.

In contrast to chimpanzees, human children and adults tend to faithfully imitate actions that are not the most efficient way to accomplish a certain aim (Flynn & Smith, 2012; Horner & Whiten, 2005; McGuigan, Makinson, & Whiten, 2011). The imitation of causally goal-irrelevant actions has been termed overimitation (Lyons, Young, & Keil, 2007). The phenomenon is usually studied by showing participants, most often preschoolers, how to retrieve a reward from a novel, causally transparent container by using one or more irrelevant actions and one relevant action. After observing the model, participants typically reproduce both the causally relevant and irrelevant actions, thereby adopting an inefficient strategy. Crucially, this strategy is not spontaneously performed when participants operate the container without observing a model first (Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons et al., 2007).

There is currently much debate about why overimitation occurs. Lyons et al. (2007) argued that children automatically encode observed actions as causally relevant and, therefore, reproduce them. This process has been dubbed *automatic causal encoding* (ACE). The ACE claim is based on the observation that children overimitate even if they are explicitly encouraged to omit any unnecessary actions and even when performing the irrelevant actions ultimately endangers receiving a reward (Lyons et al., 2011). Others have argued that social norm learning and/or the desire to affiliate with the experimenter underlie the phenomenon of overimitation (Kenward, Karlsson, & Persson, 2011; Keupp, Behne, & Rakoczy, 2013; Nielsen & Blank, 2011). Kenward (2012) had 3- and 5-year-olds observe an experimenter perform relevant actions as well as unnecessary actions in the presence of a puppet. Most children protested, some of them using normative language, when the puppet subsequently performed the task but omitted the unnecessary actions.

Neither norm learning, nor social affiliation, nor the ACE hypothesis can be ruled out at the moment. Regardless of which of these accounts holds true, some have suggested that overimitation results from children expecting others to teach them how something is done (Gergely & Csibra, 2006). Because the primary goal of the current study was not to distinguish among norm learning, social affiliation, and the ACE hypothesis, "how something is done" may henceforth refer to social norms as well as causal necessities and functional properties of artifacts.

According to the theory of natural pedagogy, humans have evolved mechanisms to transmit generic knowledge through communication (Csibra & Gergely, 2011). This generic knowledge is supposed to be shared by all members of a social group and may entail, for instance, knowledge about the functions of tools as well as cultural norms and rituals that are often cognitively opaque (Kiraly, Csibra, & Gergely, 2013). According to this theory, the (usually adult) teacher addresses the child in pedagogical interactions using certain ostensive cues such as eye contact, calling the learner's name, and speaking in a child-directed manner. These ostensive signals prompt the expectation in learners that they are about to be taught relevant and generic information that can be generalized across situations and other individuals. Several studies have demonstrated infants' and children's sensitivity to these ostensive signals and the effects of communication on early learning (e.g., Gergely, Egyed, & Kiraly, 2007; Topal, Gergely, Miklosi, Erdohegyi, & Csibra, 2008).

Corroborating the theory of natural pedagogy, some empirical evidence shows that social interaction and communicative cues increase imitative behavior in infants (Brugger, Lariviere, Mumme, & Bushnell, 2007; Kiraly et al., 2013; Nielsen, 2006). In a study by Kiraly et al. (2013), 14-month-olds

performed a head touch to turn on a light more frequently after observing a communicative model demonstrating this novel and relatively inefficient action than after incidentally observing a non-communicative model. The authors proposed that direct communication and ostensive signals may support overimitation in older children as well. However, there is evidence that toddlers (i.e., 24-month-olds) may actually rely less on communicative cues than slightly younger infants (18-month-olds) when copying specific actions as opposed to action outcomes (Nielsen, 2006). In that study, 24-month-olds, but not younger infants, tended to copy specific actions irrespective of whether the model had interacted with them or not. Shimpi, Akhtar, and Moore (2013) reported that when the model is unfamiliar, direct interaction can even suppress the imitation of arbitrary object-directed actions in 18- and 24-month-olds when compared with the observation of a third-party interaction.

It has been suggested that the importance of communicative cues directed at the participant may decline from infancy to preschool age (Lyons et al., 2011; McGuigan et al., 2011). Yet, the role of the model's communicative behavior in overimitation studies with preschoolers is currently unclear because, to our knowledge, no study so far has directly compared children's imitation of obviously irrelevant actions performed by a pedagogical model compared with a completely non-communicative model. In a study by Nielsen, Moore, and Mohamedally (2012), the model did not demonstrate the actions to the child directly but rather demonstrated the actions to another adult (explicitly expressing his intention to "show [someone] how to use this"). Children imitated irrelevant actions even though some of them had already discovered a more efficient way of achieving the goal. In that study, the knowledgeable model communicated with the child prior to the demonstration and ostensive signals were transmitted, although they were directed at another individual. In another study on overimitation in children and adults, participants watched a video-recorded presentation of relevant and irrelevant actions, but an experimenter instructed them to watch closely because they were going to "have a go in a minute," thereby also establishing a pedagogical context in which participants were supposed to learn from others (McGuigan et al., 2011). The question remains open whether preschoolers imitate causally irrelevant actions demonstrated by a completely unfamiliar and non-communicative experimenter in the absence of any instruction to learn how to perform an action or how to use a novel object.

Furthermore, it is currently unclear whether children's omission of previously learned irrelevant actions and their adoption of more efficient strategies depend on the communicative context. According to the natural pedagogy account, children should expect pedagogically transmitted knowledge to be generalizable and shared among members of a social group. The subsequent presentation of an efficient strategy by a non-communicative model, therefore, should not lead to a switch in strategies. A communicative and pedagogical second model may, in contrast, be able to teach children the efficient action as a second strategy. The latter assumption is based on the previous finding that preschoolers are able to flexibly shift between different strategies of retrieving a reward after social demonstration (Wood, Kendal, & Flynn, 2013).

In the current study we tested (a) whether communication of a model performing irrelevant actions is necessary to elicit overimitation in preschoolers and (b) whether communication of another model performing an efficient action modulates the subsequent reduction of overimitation. In Phase 1 of the current experiment, 5-year-olds observed either a communicative experimenter showing them causally relevant actions as well as clearly irrelevant actions to retrieve a reward from a transparent container (pedagogical) or an unfamiliar experimenter who never engaged with them at all (no contact). We then observed to what extent children reenacted the irrelevant actions in comparison with a baseline condition in which another group of same-aged children operated the container without a prior demonstration. In Phase 2 of the experiment, the same children were shown the efficient way to retrieve a reward from the container either by a communicative and pedagogical experimenter (no-contact-then-pedagogical and pedagogical-then-pedagogical conditions) or by an unfamiliar experimenter who did not communicate with them at all (pedagogical-then-no-contact condition). Hence, we ran three different conditions (see Table 1).

We predicted that children would imitate irrelevant actions in Phase 1 of the pedagogical-then-no-contact and pedagogical-then-pedagogical conditions, thereby replicating previous findings of overimitation following the demonstration of irrelevant actions by a communicative and pedagogical model. In Phase 1 of the no-contact-then-pedagogical condition, less or no overimitation was expected

Table 1
Experimental conditions.

	Pedagogical-then-no-contact	No-contact-then-pedagogical	Pedagogical-then-pedagogical
Phase 1: Inefficient presentation	Pedagogical experimenter	No-contact experimenter	Pedagogical experimenter 1
Phase 2: Efficient presentation	No-contact experimenter	Pedagogical experimenter	Pedagogical experimenter 2

if direct communication indeed supports learning of causally irrelevant actions from others in children.

In addition, communicative cues may affect whether children continue to use irrelevant actions after seeing the efficient way to achieve a goal. Therefore, we predicted that children would continue to perform the irrelevant actions they were taught by a pedagogical experimenter in Phase 2 of the pedagogical-then-no-contact condition even after seeing a non-communicative experimenter perform the more efficient action. This would speak to the robustness of pedagogically transmitted information. It would also be in accord with the norm learning and social affiliation hypotheses because children should be less motivated to conform to a non-communicative model than to the pedagogical experimenter because they should feel less affiliated with a person who does not establish contact with them. The ACE account, in contrast, would be more compatible with a switch to the efficient strategy regardless of the communicative context because any presentation of the efficient strategy demonstrates the expendability of the irrelevant actions and, thus, should be able to correct distorted causal beliefs. In Phase 2 of the pedagogical-then-pedagogical condition, however, the second model was also communicative. We hypothesized that this communicative model would be able to actively teach children the efficient way to retrieve the reward after they had learned the irrelevant actions from another communicative and pedagogical model because children have been shown to switch flexibly between different socially demonstrated strategies (Wood et al., 2013). In Phase 2 of the no-contact-then-pedagogical condition, children were expected to continue to use the efficient action.

Method

Participants

The study was conducted in a medium-sized German town with participants recruited from a middle-class socioeconomic background. A total of 99 5-year-old children (M = 62.5 months, SD = 1.69, 49 boys and 50 girls) participated. Participants were recruited from a pool of children who had taken part in previous studies. Children were assigned to one of four conditions: three experimental conditions (in each condition: n = 28, 14 boys and 14 girls) and one baseline condition (n = 15, 7 boys and 8 girls). Further children were excluded from the final sample because of experimenter error (3), unwillingness to participate (2), or interference of the parents (5). Another 4 children who did not manage to remove a token from the container in Phase 1 of the experiment were not included in the statistical analyses to ensure that the children's behavior was not affected by the experience of failure.

Apparatus

Children were presented with a magnetic rod and a clear plastic container revealing the irrelevance of certain actions performed in the modeling phase of the experiment (see Fig. 1). A non-transparent tube was located visibly within the container. The tube contained tokens, that is, golden marbles with small magnets attached to them. The tokens could be removed by inserting the magnetic rod into the opening of the tube at the front of the container. A black lever was attached to the top of the container, and a button that could be pushed using the rod was attached on the right side. The lever and the button had no functions and were obviously not physically connected to the tube containing the marbles.

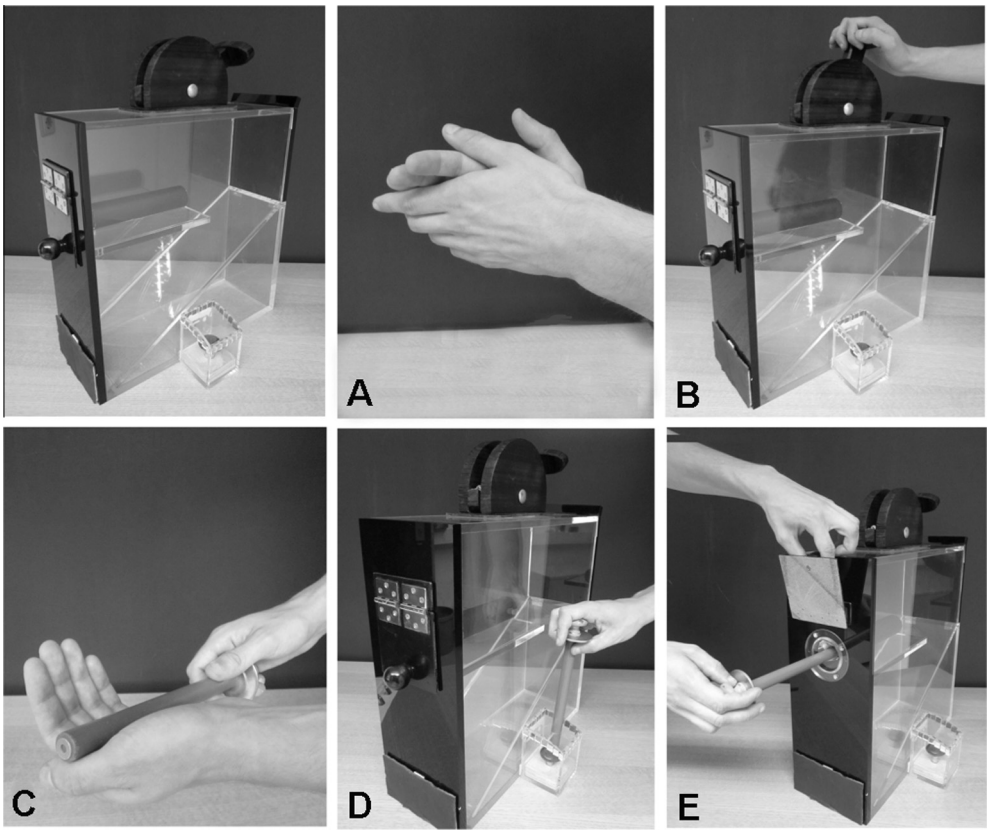

Fig. 1. The container and actions performed by the experimenters. Tokens were placed in the opaque tube within the transparent container. The inefficient demonstration consisted of four irrelevant actions (A–D) and one relevant action (E). The efficient demonstration consisted of only the relevant action.

Procedure

Children were tested individually in a quiet laboratory room. Experimental conditions are summarized in Table 1. Participants assigned to the pedagogical-then-no-contact and no-contact-then-pedagogical conditions interacted with one *pedagogical* experimenter who communicated with them, played a warm-up game, and introduced the container. In one of the two phases of the experiment, these children also observed a *no-contact* experimenter operating the container who never talked to them and never made eye contact with them. Participants in the pedagogical-then-pedagogical condition interacted with two pedagogical experimenters. Children assigned to the baseline condition interacted with one communicative experimenter who never showed them how to operate the container.

Before entering the testing room, the pedagogical experimenter welcomed the children and told them that they were going to play some games together. The parents were instructed to watch the experiment from a separate observation room via video cameras. If children refused to stay alone with the experimenter (n = 12), the parents were asked to sit in the corner of the testing room behind their children. The parents were given some magazines and were instructed to avoid any communication with their children. Children did not meet or see the no-contact experimenter before the experiment. The gender of the children and the experimenters was balanced across all conditions. Both experimenters were always of the opposite sex. Each session was recorded on video.

Warm-up phase

Each condition started with a warm-up phase. Children played an unrelated competitive game (i.e., blowing a cotton ball into a goal) with the pedagogical experimenter, who always ensured that the children won some tokens. Children were introduced to the concept that the tokens (i.e., golden marbles) could be exchanged for rewards (i.e., stickers). The game was played several times in a row until the children grew comfortable with the experimental environment.

Introduction of the container

After the warm-up phase, children were introduced to the transparent container by the pedagogical experimenter, who verbally introduced all of the conditions in the following way: "Now we are going to play another game. This game is about this special container. There are some more golden marbles hidden in this container. If you can get a marble out, you can exchange it for stickers."

Baseline condition

To establish the baseline production of the irrelevant actions, children in the baseline condition were prompted to attempt to remove a token without prior instruction or demonstration. The experimenter told the participants that they could retrieve a token however they wanted. Following this instruction, the experimenter left the room and reentered after (a) the children successfully had retrieved one token, (b) the children had stopped interacting with the box for at least 30 s, or (c) 80 s had elapsed.

Pedagogical-then-no-contact condition

In Phase 1, children observed the pedagogical experimenter retrieve a token from the container in an inefficient way. After introducing the container, the pedagogical demonstrator started the game ("Okay, let's start. It's my turn first"). If children were not paying attention, the experimenter said "Watch!" or "Look!" to ensure that the children saw what happened. Then, the pedagogical experimenter retrieved a token by using a sequence of causally irrelevant actions (Fig. 1A–D) and a causally relevant action (Fig. 1E); the experimenter clapped his or her hands (Fig. 1A), then pushed the lever attached to the top of the container back and forth once (Fig. 1B), then tapped the rod on the palm of his or her hand three times while simultaneously counting out loud to "three" (Fig. 1C), then pushed the button attached to the side of the container with the rod (Fig. 1D), and finally lifted the flap covering the opening to the tube and removed a marble by using the magnetic rod (Fig. 1E). Only the last step was causally relevant for attaining the goal. The irrelevant actions were varied systematically regarding their relation to the container and the rod; clapping involved no direct contact with either of the instruments, pushing the lever involved contact only with the container, tapping involved contact only with the rod, and pushing the button involved contact with both the container and the rod. The pedagogical experimenter did not exchange his or her token for stickers in order to emphasize his or her intention to teach. Afterward, the experimenter told participants that they could now retrieve a token on their own however they wanted. Following this instruction, the experimenter left the room. After children had successfully retrieved a token, the experimenter returned to the room and offered to exchange the token for the reward (i.e., stickers). Next, the experimenter sat down at a desk and pretended to write something down, thereby turning his or her back to the scene and not communicating anymore. This was done to ensure that a person familiar to the children was present when the unfamiliar no-contact experimenter entered the room.

In Phase 2 of the experiment, children observed the no-contact experimenter retrieve a token from the container efficiently, that is, without any irrelevant actions. The no-contact experimenter entered the room shortly after the pedagogical experimenter sat down at the desk. Without establishing contact with the children or with the pedagogical experimenter, the no-contact experimenter expressed his or her intention to retrieve a token ("I want stickers and am going to get a golden marble now"). The no-contact experimenter retrieved a token using only the causally relevant action (Fig. 1E). Then, the no-contact experimenter exchanged the token for stickers and left the room. Subsequently, the pedagogical experimenter got up from the desk and approached the children again, saying that it was the children's turn to retrieve the next token however they wanted. Following that, the pedagog-

ical experimenter also left the room, thereby leaving the children on their own. Once children had retrieved a token, the pedagogical experimenter returned and exchanged it for stickers.

No-contact-then-pedagogical condition

In Phase 1 of this condition, children also observed the inefficient way of retrieving a token. However, this time the irrelevant actions were presented by the no-contact experimenter. After the warm-up, the pedagogical experimenter told the children that he or she would start playing a game with the container soon but that first he or she needed to write something down. Children were asked to wait until the experimenter had finished. Following this explanation, the pedagogical experimenter sat down at a nearby desk and turned his or her back to the scene, pretending to concentrate on writing something down as in Phase 2 of the pedagogical-then-no-contact condition. The no-contact experimenter then entered the room and expressed his or her intention to retrieve a token while ignoring the children as well as the pedagogical experimenter and without establishing eye contact or communicating with either of them. Then, the no-contact experimenter performed the sequence of irrelevant actions (Fig. 1A–D) and relevant action (Fig. 1E) as in the pedagogical-then-no-contact condition (Phase 1). Afterward, the no-contact experimenter exchanged the token for stickers and left the room. The pedagogical experimenter then returned to the children and explained that they could now start playing the game and that they could go first. Again, the participants were told to retrieve a token however they wanted and were left alone with the container. Once children had retrieved a marble, the pedagogical experimenter returned to help exchange it for stickers.

In Phase 2, the pedagogical experimenter continued the game by announcing, "Now it is my turn." In case children were not watching, the experimenter tried to focus the children's attention on his or her actions ("Watch!" or "Look!"). Next, the pedagogical experimenter retrieved a token using only the causally relevant action (Fig. 1E). Then, the pedagogical experimenter instructed participants to remove a token however they wanted and left the room. The experimenter reentered the room as soon as the children had retrieved a token and helped to exchange it for stickers.

Hence, in Phase 1, children in both conditions received a demonstration of the entire action sequence (Fig. 1A–E, i.e., the inefficient presentation) before they were allowed to retrieve a token themselves. In Phase 2, children received a demonstration of only the causally relevant action (Fig. 1E, i.e., the efficient presentation). Whereas children participating in the pedagogical-then-no-contact condition saw the pedagogical experimenter perform the inefficient presentation and saw the no-contact experimenter perform the efficient demonstration, children participating in the no-contact-then-pedagogical condition saw the reverse combination.

Pedagogical-then-pedagogical condition

As in the other conditions children first observed the inefficient way of retrieving the tokens (Phase 1) and then the efficient way (Phase 2). In the pedagogical-then-pedagogical condition, both experimenters were equally familiar to the children and both acted in a "pedagogical" manner; that is, they engaged with the children while demonstrating their actions and never exchanged their tokens for stickers. The setup ensured that children spent an equal amount of time with both experimenters during warm-up and testing and that both experimenters spent an approximately equal amount of time talking with the children. When one of the experimenters demonstrated how tokens could be retrieved for the children, the other experimenter pretended to be writing something down at a desk with his or her back turned on the demonstration. When it was the children's turn to retrieve a token, both experimenters left the room.

Coding and reliability

The dependent measure was the number of irrelevant actions the children imitated. This individual Overimitation score (OI score) delivered values from 0 to 4, where 0 indicated that children did not imitate any of the irrelevant actions and 1, 2, 3, or 4 indicated that children performed 1, 2, 3, or 4 of the 4 possible irrelevant actions demonstrated by one of the experimenters (Fig. 1A–D). This method of coding ensured that all of the actions were weighted equally in the OI score. For the lever-pushing action to be coded, children needed to push the lever in at least one direction. Pushing the lever

back and forth (once or several times) also resulted in a score of 1. Similarly, for the tapping action to be coded, children needed to tap the rod in the palm of their hand at least once.

Children's behavior was coded by an experimenter based on edited video-recordings showing only the children acting on the container in the absence of any experimenter (i.e., the condition was not discernible). An additional independent coder who was blind to the condition, phase, and hypotheses of the study also coded all of the videos. High interrater reliability (Pearson's $r = .98$) confirmed a very good level of agreement. The experimenter's coding was used for the analyses.

Results

The number of children showing each of the four irrelevant actions in each condition is presented in Table 2. As expected based on previous findings (Lyons et al., 2007), the most frequently imitated actions involved direct contact with the container and the least frequently imitated action involved no contact with either the rod or the container (i.e., clapping hands). This was the case in all of the experimental conditions.

Preliminary analyses revealed that children's sex had no significant effect as an independent variable, so this factor is not regarded further. In a first step, OI scores in each phase of the three experimental conditions were compared with baseline (see Table 2 and Fig. 2 for means and standard errors). For this purpose, six independent-samples t tests were conducted. Level of significance was adjusted according to Bonferroni ($p = .0083$). In Phase 1 of each experimental condition, the mean OI score was significantly higher than that in the baseline condition, $ts(41) \geqslant -4.40$, $ps < .001$, $ds \geqslant 1.44$. Thus, irrespective of whether the experimenter who modeled the irrelevant actions acted in a pedagogical manner or not, children initially showed overimitation.

Results regarding Phase 2 inform us how stable this behavior was after children observed the efficient way of retrieving a token from the container. OI scores remained significantly higher compared with baseline only in Phase 2 of the pedagogical-then-no-contact condition, that is, after children observed a non-communicative stranger perform the efficient action, $t(41) = -3.38$, $p = .002$, $d = 1.11$. In both conditions with a pedagogical experimenter performing the efficient action, overimitation dropped to baseline level after children observed the pedagogical experimenter perform the efficient action: no-contact-then-pedagogical, $t(41) = -1.92$, $p = .062$, $d = 0.62$; pedagogical-then-pedagogical, $t(41) = -0.53$, $p = .601$, $d = 0.18$.

In a second step, we conducted a repeated-measures analysis of variance (ANOVA) with the between-participants factor condition (pedagogical-then-no-contact, no-contact-then-pedagogical, or

Table 2
Descriptive information on the number of children who reenacted each of the four irrelevant actions, mean Overimitation score, and standard error in each condition.

Condition	Clapping	Pushing lever	Tapping rod	Pushing button	Mean OI score (*SE*)
Baseline ($n = 14$)	0	5	0	1	0.40 (0.16)
Pedagogical-then-no-contact ($n = 28$)					
Phase 1	0	16	8	22	1.64 (0.19)**
Phase 2	0	13	4	21	1.36 (0.19)*
No-contact-then-pedagogical ($n = 28$)					
Phase 1	0	20	5	20	1.61 (0.17)**
Phase 2	0	11	2	14	0.96 (0.20)
Pedagogical-then-pedagogical ($n = 28$)					
Phase 1	2	22	12	17	1.89 (0.17)**
Phase 2	0	6	2	7	0.54 (0.17)

Note. Asterisks indicate Overimitation scores (OI scores) that are significantly greater than those in the baseline condition.
* $p < .0083$ (corresponds to $p < .05$, Bonferroni-corrected).
** $p < .001$.

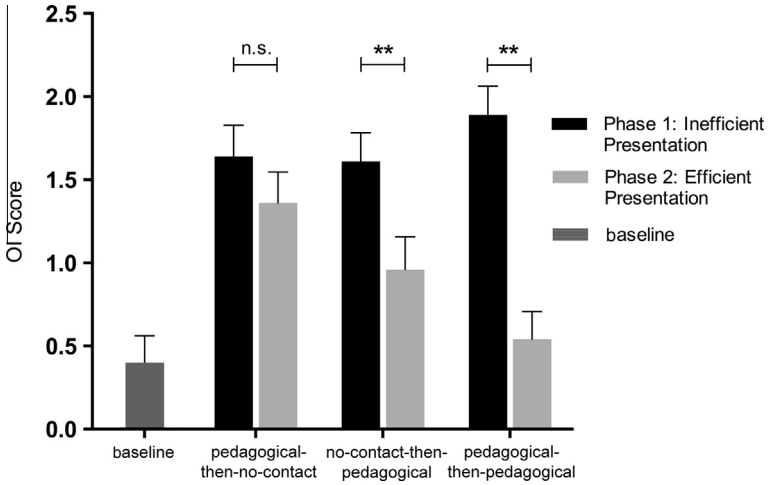

Fig. 2. Mean Overimitation scores (OI scores) in each of the experimental conditions and in the baseline condition. Error bars indicate standard errors. Asterisks indicate significant differences in mean OI scores ($^{**}p < .001$; n.s., not significant).

pedagogical-then-pedagogical) and the within-participants factor phase (1 or 2). Level of significance was set at $p < .05$. There was a significant main effect for the factor phase, $F(78) = 55.97$, $p < .001$, $\eta^2 = .41$, and a significant interaction between phase and condition, $F(78) = 9.57$, $p < .001$, $\eta^2 = .19$. To further explore the significant interaction between phase and condition, we examined whether children's OI score changed between Phase 1 and Phase 2 in each of the three conditions. Children's OI score dropped significantly from Phase 1 to Phase 2 in the no-contact-then-pedagogical condition, $t(27) = 4.12$, $p < .001$, Cohen's $d = 0.66$, and the pedagogical-then-pedagogical condition, $t(27) = 6.18$, $p < .001$, Cohen's $d = 1.50$. The difference between Phase 1 and Phase 2 was not significant in the pedagogical-then-no-contact condition, $t(27) = 1.98$, $p = .058$, Cohen's $d = 0.28$. Given the rather limited statistical power in this particular test ($1 - \beta = .32$), a small effect may have gone unnoticed. That is, a small decrease from Phase 1 to Phase 2 in the pedagogical-then-no-contact condition cannot be ruled out completely considering the high β-error probability. Even if overimitation is somewhat reduced from Phase 1 to Phase 2, it should be noted that the pedagogical-then-no-contact condition is the only condition in which children showed overimitation above baseline level in Phase 2.

Discussion

In the current study, 5-year-olds were first shown an inefficient method, involving several irrelevant actions, to retrieve tokens from a container, demonstrated either by a pedagogical experimenter or by a non-communicative experimenter. Then, children observed the efficient method to retrieve the tokens presented by another experimenter who either acted in a pedagogical manner or did not. The irrelevant actions were rarely performed spontaneously by a group of same-aged children in a baseline condition. After the first demonstration, children imitated irrelevant actions in each of the experimental conditions, that is, regardless of whether they were presented by a pedagogical experimenter or a no-contact experimenter. Interesting differences in children's behavior were observed, however, after the subsequent presentation of the efficient way to retrieve the tokens. Only when children were shown the efficient action by a pedagogical experimenter did their performance of irrelevant actions drop to baseline level. This was found irrespective of whether they had initially learned the irrelevant actions from a pedagogical experimenter or a non-communicative experimenter (i.e., in both the no-contact-then-pedagogical and pedagogical-then-pedagogical conditions). When children were shown the efficient action by a non-communicative experimenter (pedagogical-then-no-contact condition), their imitation of irrelevant actions dropped only slightly and was still significantly above baseline level.

Our findings add relevant information to the current discussion concerning the importance of communication for the cultural transmission of actions that are apparently irrelevant or inefficient. Replicating previous findings, preschoolers in our study imitated irrelevant actions that were presented by an experimenter. Children may automatically encode irrelevant actions that are performed by an adult model as causally relevant (Lyons et al., 2011), or they may reproduce these actions out of a desire to conform to cultural norms (Kenward et al., 2011; Keupp et al., 2013) or to be liked by the model (Nielsen & Blank, 2011). It should be noted that in the current study the model was never present when children acted on the container in order to minimize social pressure to act in a certain way. Children were also encouraged to retrieve the token however they wanted. Still, it cannot be ruled out that the intrinsic motivation to comply with social norms or to affiliate with the experimenter prompted children to act like the model even when they were alone.

Interestingly, and in contrast to our prediction, children initially reenacted the irrelevant actions no matter whether these actions were demonstrated by a pedagogical experimenter or by an unfamiliar and non-communicative experimenter. This was true even though the no-contact experimenter never interacted with children and avoided any contact before or during the experiment. The no-contact experimenter never expressed the intention to teach or show anyone how to operate the container and instead made it clear that he or she removed tokens from the container in order to exchange them for stickers. This finding seems surprising given that direct communication and ostensive signals are thought to improve the transmission of cultural knowledge (Gergely & Csibra, 2006). Our results suggest that preschoolers imitate irrelevant actions even when performed by a complete stranger in the absence of communication and instruction. The incidental observation of actions whose purpose is opaque in relation to the goal of the action, thus, seems to be sufficient to trigger overimitation in 5-year-olds.

This result does not necessarily contradict previous findings showing that communication and ostensive signals increase the imitation of arbitrary and inefficient means to achieve a goal in younger children and infants (Kiraly et al., 2013). Younger children may well be more reliant than older children on social cues to infer at what level of detail an action should be imitated, and they may resort to goal emulation in the absence of communication. In contrast, older children with increased cognitive resources may be able to encode more aspects of an observed action and reproduce even complex action sequences at a high level of detail and fidelity without requiring the model to indicate which aspects of the action are actually relevant (see also Lyons et al., 2011, and McGuigan et al., 2011, for similar argumentation). In accordance with this notion, 18-month-olds were more inclined to open a box in a specific way when this was demonstrated by a model who was engaging in a social interaction with them (i.e., who was acting in a pedagogical manner according to Gergely & Csibra, 2006) as compared with a model who acted disinterested and aloof, whereas 24-month-olds imitated the model's way of opening a box equally irrespective of the model's behavior toward them (Nielsen, 2006). At the same age, direct interaction was even found to reduce imitation of arbitrary object-directed actions from an unfamiliar model when compared with the observation of a third-party interaction (Shimpi et al., 2013).

Phase 2 of our experiment, however, revealed an interesting effect of communication on children's behavior. In all experimental conditions, children first saw the inefficient method of retrieving tokens and then, after retrieving a token themselves, saw the efficient method demonstrated by another experimenter. When the inefficient method was demonstrated by a pedagogical experimenter and the efficient method was shown by a non-communicative experimenter (pedagogical-then-no-contact condition), children's overimitation performance did not drop significantly and these children still performed more irrelevant actions than children in the baseline condition. When children were shown the efficient way to retrieve tokens by a pedagogical experimenter, overimitation dropped significantly and was no longer significantly different from baseline. This was the case irrespective of whether they had initially learned the irrelevant actions from a no-contact experimenter (no-contact-then-pedagogical condition) or a pedagogical experimenter (pedagogical-then-pedagogical condition).

Thus, it seems that direct instruction and communication affect the reduction of overimitative behavior more than they influence its elicitation in preschoolers. Our results show that preschoolers are able to learn functionally irrelevant actions from a completely non-communicative model. This

speaks to the robustness of the phenomenon and suggests that children can acquire apparently inefficient action strategies through incidental observation. However, when children had already acquired an inefficient strategy, observing a non-communicative experimenter perform the efficient action led to only a small decline in overimitative behavior that was still significantly above baseline level. It is possible that children in the pedagogical-then-no-contact condition would have eventually omitted the irrelevant actions had we administered more trials or had these children observed more than one non-communicative model retrieve the token without the irrelevant actions. In contrast, direct communication seems to help children to adjust socially acquired inefficient action strategies quickly even after only one pedagogical demonstration of the efficient action.

How do the current findings relate to theoretical accounts on overimitation? If overimitation is indeed due mostly to norm learning (Kenward, 2012; Kenward et al., 2011; Keupp et al., 2013), it makes sense for children to initially imitate any seemingly knowledgeable adult performing an unknown action even when the adult does not communicate with them. Similarly, they may imitate the unfamiliar experimenter for the sake of social affiliation as long as they have not observed any other way of retrieving tokens performed by someone else to whom they might feel more connected. In Phase 2 of the experiment, children were faced with a conflict. They needed to decide which model to follow. After being shown two strategies, they chose to maintain the strategy or switch to the strategy employed by the pedagogical experimenter (pedagogical-then-no-contact and no-contact-then-pedagogical conditions), with whom they presumably shared a stronger bond (i.e., social affiliation) and whose normative behavior they may have been more motivated to copy. In the pedagogical-then-pedagogical condition, both experimenters were equally familiar and pedagogical. Here, it seems that children's behavior was flexible and they performed the strategy they had seen last. This is in accordance with the previous finding that children may switch strategies on how to retrieve a reward from a container after social demonstration (Wood et al., 2013).

It would be interesting to further investigate the norm learning account using our paradigm by manipulating group membership of the two experimenters. Children should be more motivated to imitate a member of their own social group even if he or she performs an inefficient action sequence. Furthermore, it might be informative to test children's behavior when the efficient strategy is presented first and the inefficient strategy is presented second. Children might switch to the inefficient strategy presented by a pedagogical experimenter even after having performed the efficient strategy before if they perceive causally irrelevant actions to be potentially socially relevant.

The ACE account is also compatible with our results in Phase 1 of the experiment, but it cannot explain why overimitation was maintained after the demonstration of the efficient action by a non-communicative experimenter in Phase 2 of the pedagogical-then-no-contact condition. We deem it unlikely that children simply paid less attention to the no-contact experimenter given that they observed him or her closely and learned the irrelevant actions from the no-contact experimenter equally well as from the pedagogical experimenter in Phase 1 of the experiment.

In future studies, it will be important to tease apart aspects of the model's behavior relating to pedagogical behavior and ostensive signals from socially affiliative behavior. In the current study, the pedagogical experimenter was also the one who was more familiar than the no-contact experimenter and who actively engaged with participants. It would be possible to present an experimenter on a stage or through video-recording who is unfamiliar to the children but who displays ostensive signals such as eye contact. This would inform us whether the reduction of overimitative behavior as shown in the current study relies on pedagogical signals alone or whether a relationship with the pedagogical experimenter (as built up in the warm-up phase of the current study) is necessary.

Furthermore, the knowledge status of the experimenter may play a role. In our study, both types of experimenters may have appeared to be equally knowledgeable. Even though the no-contact experimenter displayed no pedagogical intention, he or she did not hesitate and acted on the container in an intentional manner directly after entering the room. In a recent study, preschoolers showed more imitation of irrelevant actions when the model claimed to be knowledgeable and expressed a pedagogical intention than when the model expressed the intention to "figure out" how to use an unfamiliar and causally opaque object (Buchsbaum, Gopnik, Griffiths, & Shafto, 2011). When a causally transparent object is used (Wood, Kendal, & Flynn, 2012), 5-year-olds imitate irrelevant actions more frequently

from an adult model than from a peer, although the model's self-professed knowledge status had only a weak effect in this study.

To conclude, we found no evidence that communication and direct instruction affect the imitation of irrelevant actions on a novel and transparent container in preschoolers per se. Thus, pedagogical cues may be more effective in guiding imitative behavior in younger children and infants (Kiraly et al., 2013) than in older children (i.e., preschoolers). However, the reduction of overimitative behavior seems to be facilitated if a pedagogical and communicative experimenter, as compared with a non-communicative experimenter, models the efficient action. Our findings are compatible with accounts on overimitation that stress the importance of norm learning and social affiliation (Kenward, 2012; Kenward et al., 2011; Keupp et al., 2013; Nielsen & Blank, 2011).

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