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Why do we imitate nonsense? The underlying motivations of overimitation

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I. MANUSCRIPT

Hoehl, S., Zettersten, M., Schleihauf, H., Graetz, S., & Pauen, S. (2014). The role of social interaction and pedagogical cues for eliciting and reducing overimitation in preschoolers. *Journal of Experimental Child Psychology*, *122*, 122-133.

II. MANUSCRIPT

Schleihauf, H., Graetz, S., Pauen, S., & Hoehl, S. (2017). Contrasting social and cognitive accounts on overimitation: The role of causal transparency and prior experiences, *Child Development*.

III. MANUSCRIPT

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1. INTRODUCTION

Imagine you are five years old and you are with your parents at a fair in a foreign country and for whatever reason you have a desire for bubblegum. By happy coincidence, you walk by a bubblegum vending machine. The machine looks a little different from those you are used to. It has the familiar slot to insert coins and a wheel you have to turn to get bubblegum, but also a lever on top, which you have never seen before. You are not completely sure if this machine needs to be operated differently to the ones you know from home. You ask your parents for coins and get some. Another person seems to share the same cravings and steps up to the machine in front of you. She taps three times on top of vending machine. She pushes the lever back and forth. Then, she inserts a coin. Afterwards she taps on the top three times again. Finally, she turns the wheel and gets her bubblegum. You see her happily stick the gum into her mouth as she leaves. You are the next in line. How will you operate the bubblegum machine? To answer that question, I would like to go back in time and have a look on that question from an evolutionary perspective.

Humans are an incredible successful species. They are able to adapt to the cold environment of the Antarctic, to humid environment of the tropical forest, but also to the hot and dry environment of the African savannah. What is it that makes humans the probably most adaptive of all species? You might think it is our biological superiority. However, there are many species that by far overtrump us regarding their biological adaption. An arctic fox can live in the cold without needing a warm coat, and a camel can survive in the desert without water up to two weeks. The key to our adaptability seems to be our culture (e.g., Henrich, 2016; Tomasello, 1999); that we dispose over knowledge and skills that we learned from others. For example, humans were able to survive in the artic because we learned for example to sew warm cloth, to build igloos and to hunt polar bears and seals, and we were able to survive in the savannah because we learned for example how to use roots as a source for water. It was not necessary for each individual to invent these survival tricks from scratch, we could learn from others. Our adaptability seems to be a product of gene–culture coevolution (e.g., Henrich, 2016). We know quite well, how genetic information is transmitted from one generation to another, but how is cultural knowledge transmitted? An essential mechanism for cultural transmission is social learning. Without social learning the species human would probably not have been able to survive (Boyd, Richerson, & Henrich, 2011). Therefore, it is likely that we developed special and pronounced forms of social learning. One form of social learning that received a lot of attention in the last decade is the imitation of causally irrelevant actions.

The imitation of actions that are perceivably irrelevant to reach a certain goal, has been termed 'overimitation' (Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons, Young, & Keil, 2007). In general, imitation is a particularly pronounced social learning strategy in humans. It enables us to quickly acquire novel actions and new problem-solving strategies, without putting much effort into working out a solution on our own. However, humans do not only copy actions with a clear purpose, we also have a pervasive tendency to copy behaviors whose purpose is unclear. Sometimes such actions are subject to a purpose that is not discernible at the time; however, sometime such actions are completely unrelated to a set goal. In these instances, copying goal-irrelevant actions seems to be an inefficient learning strategy. Therefore, the legitimate question arises: Why do we do so?

Coming back to the bubble gum example. According to recent scientific findings, it is quite likely that you would tap on the machine three times, insert your coin, tap again and then turn the wheel to get your bubblegum. But why would you do so? You might think that the tapping is necessary to make the machine work. You might be reasoning that, since the tapping worked for the other person and you are not certain how this machine works, you would rather just trust in a strategy that has already been proven successful. You might think that you are supposed to tap and it might be rude not to do it. Or you might just think that the tapping looked like a fun thing to do, so you thought 'Why not?'.

In my dissertation I will present work aimed to investigate the underlying motivations of overimitation. I will commence with giving a short introduction on what overimitation is and how it is typically operationalized. I will then outline recent explanatory models for the phenomenon. Then, I will summarize three empirical studies conducted to test the validity of these explanatory models. On the basis of the results of these studies, I will finish by introducing a new integrative explanatory model for overimitation.

2. What is Overimitation?

Imitation of causally irrelevant actions was first systematically tested and reported in 2005 in a groundbreaking study by Horner and Whiten (2005). Three- to 4-year-old children and young chimpanzees observed an experimenter who retrieved a reward from a puzzle box with a series of actions that were either causally necessary or unnecessary. When the box was opaque, both chimpanzees and children tended to copy both the necessary as well as the unnecessary actions when retrieving the reward. This was unsurprising since the mechanisms of the box were hidden from view, leaving it unclear to an observer whether the actions might in fact be causally necessary. However, when the opaque box was replaced with a transparent box a striking difference emerged between the two species. With the box's inner mechanisms transparent, it was visible that some of the demonstrated actions had no effect on the reward. Whereas chimpanzees omitted unnecessary actions, human children continued to imitate the causally irrelevant actions. Two years after the this first report, Lyons, Young, and Keil (2007) labeled this phenomenon "overimitation".

Since the first report of overimitation, a rapidly growing number of studies has addressed imitation of unnecessary actions, especially in children (Brugger, Lariviere, Mumme, & Bushnell, 2007; Kenward, Karlsson, & Persson, 2011; Lyons et al., 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen & Blank, 2011). Children need to learn to find their way around in a complex world. The amount of knowledge and skills they need to learn is incredibly large. Therefore, it is especially interesting to investigate overimitation in children.

Many studies on overimitation shared the same paradigm, build on the original design by Horner and Whiten (2005). In this widespread paradigm (e.g., McGuigan, Makinson, & Whiten, 2011; Wood, Kendal, & Flynn, 2012), participants first see how a demonstrator retrieves an object from a puzzle box using a combination of necessary and unnecessary actions. After observing the demonstrator, it is the participants turn to either extract a reward (e.g., Horner & Whiten, 2005) or to extract objects which are needed to fulfill another task (Kenward, 2012; Keupp, Behne, Zachow, Kasbohm, & Rakoczy, 2015).

Most researchers restrict the term overimitation to events in which it is possible for the participants to perceive the causal irrelevance of additional actions, as when a necessary physical connection between a tool and its target is visibly lacking. This perceptibility is either ensured by using a transparent puzzle box (e.g., Horner & Whiten, 2005), by demonstrating actions on a disconnected object (Lyons et al., 2011; Taniguchi & Sanefuji, 2017) or by performing superficial touching or tapping actions (Nielsen, Simcock, & Jenkins, 2008). However, occasionally the term has been used in a broader sense, for example in experiments in which causal irrelevance of the modeled actions is not perceptible (Flynn & Smith, 2012) or in experiments that investigate the imitation of actions that are causally relevant but executed in an inefficient and unusual manner, such as turning on a light with the forehead (Buttelmann, Carpenter, Call, & Tomasello, 2007; Corriveau et al., 2017; Nagell, Olguin, & Tomasello, 1993; Nielsen & Hudry, 2010). Recently, Hoehl et al. (2018) have suggested to define "overimitation as the imitation of perceivably causally unnecessary actions" that are performed in addition to causally necessary actions in relation to a goal. This helps to emphasize that "the term "over"-imitation neither implies that actions are performed that go beyond the actions performed by a demonstrator, nor that the behavior is necessarily maladaptive or dysfunctional in children's everyday lives" (Hoehl et al., 2018). I will use this narrower definition of overimitation in terms of imitating perceivably causally unnecessary actions.

After having introduced the phenomenon, I will next give a brief overview of recent explanatory models of overimitation.

3. Recent Explanatory Models for Overimitation

In over 10 years of research on overimitation, several explanatory models for the phenomenon have been proposed. Some of them focus on children's need to learn about objects whose causal properties are not immediately obvious. For example, Whiten and colleagues (Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009) argue that on average, it is profitable for children to copy much of the behavioral repertoire they observe in everyday life. This may be specific for the culturally enriched environment of humans. The majority of copied actions will be advantageous; and if a small percentage of these actions turn out not to be advantageous or even costly, these wrongly assimilated aspects of imitated actions can be omitted later on. This is termed the "copy first – refine later" approach (Whiten et al., 2009). In this sense, overimitation is proposed to serve a crucial function in the transmission of cultural knowledge (Nielsen & Tomaselli, 2010). Overimitation is an adaptive learning strategy supporting humans' ability to learn not only conventional knowledge and rituals, but also instrumental skills (Legare, 2017) much faster than would be possible if copying required a full causal understanding of each action. Relatedly, Lyons and colleagues (Lyons et al., 2007; 2011) have argued that children automatically encode observed actions as causally relevant and therefore reproduce them (automatic causal encoding hypothesis). According to this theory, overimitation is an automatic and therefore "unavoidable" behavior. These theories imply that children do not understand or at least do not question if the performed actions are causally relevant or irrelevant.

Other authors focus more on the social motivations underlying overimitation. Some argue that overimitation is driven by children's desire to affiliate with the demonstrator or to communicate their similarity (Nielsen & Blank, 2011). Conclusions of older studies, that infants (Hanna & Meltzoff, 1993) as well as children (Roberts, Wurtele, Boone, Metts, & Smith, 1981) imitate with the hope to benefit or gain attention from others, and that teachers and peers show greater affinity for children who are more imitative (Thelen, Frautschi, Roberts, Kirkland, &

Dollinger, 1981), support these affiliative accounts. Another subcategory of social explanatory models for overimitation, focuses on the urge or pressure to follow norms, conventions or rituals (Kenward, 2012; Kenward et al., 2011; Keupp, Behne, & Rakoczy, 2013; Legare & Nielsen, 2015).

In line with these social accounts, a more recent model tries to combine explanations for overimitation focusing on social motivations and explanations for selective imitation focusing on goal-directed motivations. Over and Carpenter (2012a; 2012b) suggested that children's tendency to copy observed actions depend on their goals in specific situations. These goals could either be learning goals (i.e., learning about the function of an apparatus), social goals (i.e., establishing a good relationship with somebody), or a combination of both (i.e., following the rules of a game). Accordingly, if children have learning goals, they tend to behave more efficiently; if children have (additional) social goals, they are poised to faithfully imitate even actions that are not goal-directed.

Related to this integrative theory, Legare and colleges (e.g., Legare & Herrmann, 2013) proposed that cultural learning in humans involves a ritual/conventional stance (i.e., trying to find a rationale for actions based on social convention) as well as an instrumental stance (i.e., trying to find a rationale for actions based on physical causation). Whereas the ritual stance is associated with high fidelity imitation and overimitation, the instrumental stance is associated with selective imitation or emulation (copying of action outcomes). The ritual stance or an orientation towards social goals seems to be triggered by different cues, such as the missing perceptibility of an action's causal purpose (Kapitány & Nielsen, 2015), start- and end- state equivalence (Watson-Jones, Legare, Whitehouse, & Clegg, 2014), normative language (Legare, Wen, Herrmann, & Whitehouse, 2015), the presence of the person who demonstrated the causally irrelevant actions (Nielsen & Blank, 2011) or by ritual-like action characteristics such as repetition, redundancy, or formality (Boyer & Liénard, 2007; Bulbulia & Sosis, 2011; Eilam, Zor, Szechtman, & Hermesh, 2006; Kapitány & Nielsen, 2016; Legare & Souza, 2012; Rossano, 2012). These social explanatory models imply that children may have an understanding of causal irrelevancy of demonstrated actions, but copy them anyways, especially in socially encouraging situations.

It is still unclear which of these models best explains overimitation. The following three empirical studies were designed to contrast the predictions of explanatory models focusing on social motivations and explanatory models focusing on erroneous causal reasoning.

4. CONTRASTING SOCIAL AND CAUSAL EXPLANATORY MODELS – THREE EMPIRICAL STUDIES

As reviewed in the previous section, existing theories still present a somewhat ambiguous picture about the underlying motivations of overimitation. The aim of this dissertation is to shed further light on when and why children overimitate. In three studies, we contrasted social and causal explanatory models by increasing children's social motivations to overimitate on one hand and presenting them with a more efficient strategy to solve the problem on the other hand. To create this contrast, we used a paradigm with two phases and two demonstrators. In the following, I will describe the general paradigm, which was used in all three studies that are part of this dissertation. Then, I will summarize methods and results of the studies. In the next chapter, I will discuss the combined findings of these studies and propose a new integrative explanatory model of overimitation.

In all three studies we used a paradigm with two successive phases. In one phase of the paradigm one demonstrator showed an inefficient strategy including causally irrelevant actions to extract a token from a puzzle box. In the other phase a different demonstrator performed an efficient strategy to extract a token without any irrelevant actions. After each demonstration, the child was asked to extract a token him- or herself. Therefore, there were two testing phases, one after the inefficient and one after the efficient demonstration. Including two phases allowed us to investigate the consistency of overimitation and to identify what conditions lead to behavioral change (i.e., whether a child would switch from an inefficient to an efficient strategy, or vice versa). In all three studies presented in this dissertation, the child was left alone during each testing phase.

The overimitation task used in these studies involved a transparent puzzle box with a non-functional button on the side and a non-functional lever on top (see Figure 1). The only relevant action was opening a flap and inserting a magnetic rod (Figure 1E). This rod allowed participants to remove a magnetic marble that could subsequently be exchanged for stickers. For the inefficient strategy, the demonstrator performed four irrelevant actions that varied systematically regarding their relation to the puzzle box and the rod; clapping (Figure 1A) involved no direct contact with either of the instruments, pushing the non-functional lever (Figure 1B) involved contact only with the puzzle box, tapping the rod on the palm of the hand (Figure 1C) involved contact only with the rod, and pushing the non-functional button (Figure 1D) involved contact with both the puzzle box and the rod. Therefore, children saw two irrelevant actions that involved physical contact with the puzzle box and two irrelevant actions that did not involve contact with the puzzle box.

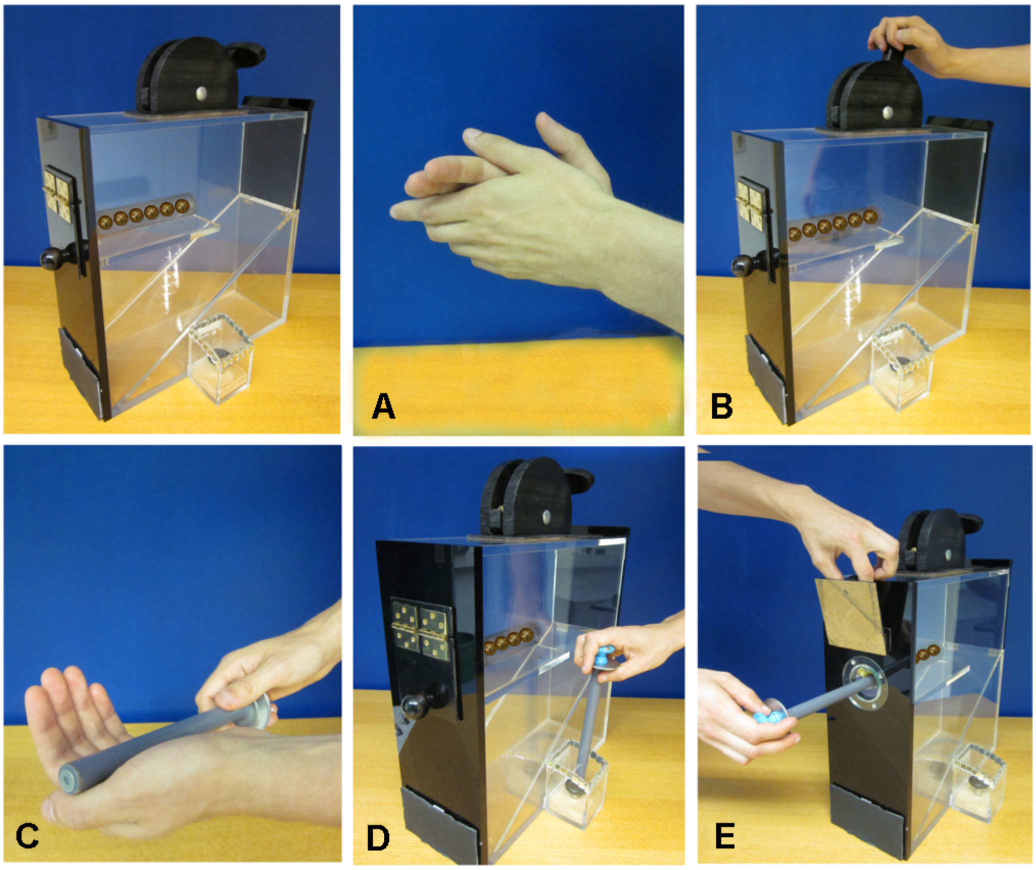

Figure 1. The puzzle box and actions performed by the demonstrators. Tokens were placed in the tube within the transparent puzzle box. The tube was opaque in Study 1 and transparent in Study 2 and 3. The inefficient demonstration consisted of four irrelevant actions (A–D) and one relevant action (E). The efficient demonstration consisted of only the relevant action (E).

The two-phased paradigm with two demonstrators allowed to socially emphasize the inefficient or the efficient strategy independently. In Study 1 and 2, we increased children's social motivation by manipulating whether the demonstrator that performed either the efficient or the inefficient strategy was communicative or not. In Study 3 we increased children's social motivation by manipulating whether the demonstrator that performed one strategy or the other was an in-group or out-group member. Whereas in Study 1, Study 2 (Experiment 1) and Study 3 children learned the inefficient strategy first (Phase 1) and the efficient strategy second (Phase 2), in Study 2 (Experiment 2a and 2b) demonstration order war reversed, therefore they learned the efficient strategy first (Phase 1) and the inefficient strategy second (Phase 2). With the demonstration of the efficient strategy to extract a token in the first phase, we could ensure that children know that some of the demonstrated actions were irrelevant when they observed them in the second phase. With the demonstration of the efficient strategy to extract a token in the second phase, it was possible that children did not recognize the irrelevancy of the demonstrated actions when they observed them. This way we could test if overimitation is a result of causal distortion.

This paradigm allowed to contrast social and causal explanatory models. Whereas explanatory models focusing on social motivations predicted that children overimitate even after discovering that some of the demonstrated actions are irrelevant (especially when irrelevant actions are emphasized through social interaction), explanatory models focusing on children's causal distortion predict that they should stop overimitating as soon as the irrelevancy of demonstrated actions is revealed.

Given the relatively restricted range of the dependent variable (Overimitation-Score with a minimum of 0 and a maximum of 4) in the reported studies, we conducted also non-parametric tests respectively to all reported *t*-tests. As these yielded the same outcomes, only parametric statistics are reported in the attached publications and manuscripts.

4.1 STUDY 1 - THE INFLUENCE OF COMMUNICATION ON OVERIMITATION

In most studies on overimitation, a demonstrator communicatively shows children an inefficient strategy to retrieve a reward from a puzzle box. Communication or more specifically ostensive cues such as eye contact, speaking the child's name, and speaking in a child-directed manner seem to be some of the most important signals for transmitting generic knowledge (Csibra & Gergely, 2011). 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 (Király, Csibra, & Gergely, 2013). According to the theory of natural pedagogy, ostensive signals prompt the expectation in learners that they are about to be taught relevant information that can be generalized across situations and other individuals Therefore, it is likely that a demonstrator's communicativeness is a main cause why children overimitate. Some empirical findings show that social interaction and communicative cues increase imitative behavior in infants (Brugger et al., 2007; Király et al., 2013; Nielsen, 2006). Yet, the role of the demonstrator's communicative behavior in overimitation studies with preschoolers has been unclear. To my knowledge, no study has yet directly compared children's imitation of irrelevant actions performed by a communicative demonstrator compared to a completely non-communicative demonstrator. Study 1 was designed to fill this gap.

In Study 1 we tested (a) whether the communicativeness of a demonstrator performing irrelevant actions is necessary to elicit overimitation in preschoolers or whether preschoolers also overimitate when the demonstrator is completely unfamiliar and non-communicative (Phase 1) and (b) whether children's omission of previously learned irrelevant actions and their adoption of a more efficient strategy is dependent on the communicativeness of the demonstrator (Phase 2). In Phase 1, 5-year-olds observed either a communicative experimenter who interacted with them and talked to them, or an unfamiliar experimenter who ignored the children and never engaged with them at all demonstrating the inefficient strategy to extract a marble. 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 puzzle box without a prior demonstration. In Phase 2 of the experimental conditions, the same children were shown the efficient way to retrieve the reward either by a communicative experimenter or by a non-communicative experimenter. Afterwards, they had the opportunity to get a second token themselves. When it was their turn to manipulate the box, children were always alone in the room.

According to the natural pedagogy account, children should expect pedagogically transmitted knowledge to be generalizable. In line with the theory of natural pedagogy and the social explanatory models of overimitation, we hypothesized that the demonstration of an inefficient strategy would lead to higher overimitation rates when the demonstrator is communicative compared to when the demonstrator is non-communicative and that the subsequent demonstration of an efficient strategy by a non-communicative demonstrator would not lead to a switch in strategies, whereas a communicative and pedagogical second demonstrator would be able to teach children the efficient action as a second strategy. In contrast, explanatory models focusing on children's causal distortion would predict that children stop overimitating as soon as they know about the irrelevancy of demonstrated actions, independently of the demonstrator's communicativeness.

Hoehl, S., Zettersten, M., Schleihauf, H., Graetz, S., & Pauen, S. (2014). The role of social interaction and pedagogical cues for eliciting and reducing overimitation in preschoolers. *Journal of experimental child psychology*, *122*, 122-133.

Contrary to the predictions based on the natural pedagogy account, children imitated causally irrelevant actions (mostly actions that involved contact with the puzzle box) at a similar frequency in the first phases of all conditions, irrespective of whether the demonstrator addressed them directly or not. This is surprising given the severe difference between the demonstrator's behaviors in the study. Thus, this finding speaks to children's eagerness to imitate others even when only observing actions that are not necessary to achieve the goal. However, communication was found to play a role in the second phase of the experiments. Children continued to perform non-functional actions in the second phase after observing a non-communicative demonstrator performing the efficient action only. In contrast, when the second demonstrator showed them the efficient strategy in a communicative manner, children switched to the efficient strategy irrespective of whether the first demonstrator had been communicative or not. Thus, it seems that although communication is not necessary for overimitation to occur, it helps children to abandon it for a more efficient strategy.

4.2 Study 2 - The Role of Causal Transparency and Prior Experiences

Even if it is in general perceivable that some of the demonstrated actions are irrelevant (e.g., because the apparatus is transparent), we cannot be sure that children really recognize these actions as being causally unnecessary. However, children's knowledge about the functionality of an apparatus is likely to influence whether they copy irrelevant actions or not. To investigate this influence, we conducted two experiments in which we increased the causal and functional transparency of the task. In Experiment 1, we increased the visual transparency of the puzzle box. In Experiment 2, we increased the functional transparency by teaching children the efficient strategy at the beginning of the experiment.

In Experiment 1, we investigated whether children imitate task irrelevant actions even when they see the reward is unaffected by these actions. Most overimitation studies (for an exception see Gardiner, 2014) used an opaque reward location so that children could not see the reward before retrieving it (Berl & Hewlett, 2015; Horner & Whiten, 2005; McGuigan et al., 2007; Nielsen, Tomaselli, Mushin, & Whiten, 2014). In some studies, the puzzle box itself was entirely opaque and non-functional actions were performed on the outside (Nielsen & Blank, 2011; Nielsen & Tomaselli, 2010). Therefore, children may have inferred that the demonstrated actions affected the reward through some hidden mechanism. In our studies, the tube was the crucial part of the apparatus; as long as it was opaque, the relative impact of causal and social information on overimitation was hard to discern. Children could not see the crucial event—how the tool that was inserted into the tube connected with the reward. Therefore, they could not know for sure that the demonstrated irrelevant actions had no bearing on the outcome of the relevant action. To investigate how the visibility of the reward affects children's imitation of non-functional actions, we exchanged the reward containing opaque tube in our puzzle box with a transparent tube.

We adopted the design described in Study 1, in which we found that children continued to overimitate even after watching a non-communicative demonstrator perform the efficient strategy (but not after watching communicative demonstrations of the efficient strategy). Therefore, we communicatively demonstrated the inefficient strategy (Phase 1), whereas the efficient strategy was demonstrated non-communicatively (Phase 2). By replicating this procedure, we were able to test whether children would both initially overimitate and persist in overimitating despite the subsequent demonstration of the efficient strategy, even when the reward location was transparent. Furthermore, pairing the efficient demonstration with a non-communicative demonstrator allowed the child to merely observe the efficient demonstration, enabling us to evaluate the impact of causal and functional information about the task with only minimal social input.

Theories focusing on children's causal reasoning (Lyons et al., 2007, 2011; Whiten et al., 2009) predict that children overimitate less when they can see that the reward is unaffected by non-functional actions (Phase 1) and that they stop overimitating after having observed the efficient strategy, that is, having seen that there is no functional reason for performing these non-functional actions in order to achieve the reward (Phase 2). In contrast, social accounts predict that children overimitate even when they can see that the reward is unaffected by non-functional actions (Phase 1) because this should underscore the social-normative value of the demonstrated actions. Moreover, according to social accounts, they should continue to overimitate despite having seen the efficient strategy performed by a non-communicative demonstrator, since the normative information provided by the communicative demonstrator should outweigh additional information provided in the absence of communicative cues (Phase 2).

> Schleihauf, H., Graetz, S., Pauen, S., & Hoehl, S. (2017). Contrasting social and cognitive accounts on overimitation: The role of causal transparency and prior experiences, *Child Development*. (Experiment 1)

After the first demonstration, children imitated non-functional actions (mostly actions that involved contact with the puzzle box) with similar frequency to when the reward location was opaque. After observing the efficient strategy next, the rate of overimitation decreased slightly, but was still above baseline level, that is, children still overimitated. Therefore, we found the same pattern of results as in Study 1 and concluded that the transparency of the reward location did not affect children's tendency to overimitate. This means that our results are more in line with social accounts than causal accounts of overimitation.

In Experiments 2a and 2b, we tested whether children would switch from an efficient strategy to an inefficient strategy. Would children perform an inefficient strategy, even if they had observed and carried out a more efficient strategy beforehand? By switching the order of efficient vs. inefficient strategy observations, we could ensure that children knew the inefficient actions had no causal function. In Phase 1, one demonstrator performed the efficient strategy and let the children interact with the puzzle box to try out this strategy on their own. In Phase 2, another demonstrator presented the inefficient strategy before it was the child's turn again. We varied between Experiment 2a and 2b whether the efficient demonstrator was communicative or not. In Experiment 2a, efficient and inefficient strategies (Phase 1 and Phase 2) were demonstrated by a communicative demonstrator; in Experiment 2b, the efficient strategy was demonstrated by a non-communicative demonstrator (Phase 1), whereas the inefficient strategy was presented by a communicative demonstrator (Phase 2). Therefore, in Experiment 2b only the inefficient strategy was accompanied by social-communicative cues.

Causal accounts (Lyons et al., 2007; 2011) predict that children will not imitate irrelevant actions when they are aware of a more efficient strategy (i.e., neither in Experiment 2a nor in Experiment 2b). In contrast, social accounts (Gergely & Csibra, 2006; Kenward, 2012; Nielsen & Blank, 2011) predict that children may also switch from an efficient to an inefficient strategy if the latter is demonstrated by a socially engaging partner (Experiments 2a and 2b), and especially if the efficient strategy is presented non-communicatively (Experiment 2b).

Schleihauf, H., Graetz, S., Pauen, S., & Hoehl, S. (2017). Contrasting social and cognitive accounts on overimitation: The role of causal transparency and prior experiences, *Child Development*. (Experiment 2a & 2b)

Our results were in line with the predictions of theories highlighting causal and functional knowledge. In both experiments, children's performance of irrelevant actions did not rise above baseline level following the demonstration of the inefficient strategy. However, a few children did switch to an inefficient strategy. Whereas the overall findings of Experiment 2 a and 2b supported theories highlighting the role of causal and functional knowledge, it may be interesting to investigate in future research how the children who did switch to an inefficient strategy distinguish to the children who maintained with the efficient strategy.

Looking at Experiment 1, 2a and 2b together, it seems like children's social motivation to comply with a communicative demonstrator and the children's functional experience (e.g., demonstrating the efficient strategy first), have an impact on their choice to either imitate irrelevant actions or to copy observed actions selectively, in spite of the task's visual causal transparency (e.g., transparent reward location). However, whereas Experiment 1 supported social accounts, Experiments 2a and 2b pointed to the relevance of causal accounts highlighting the role of causal and functional knowledge. At first glance, these results seem somewhat contradictory. In chapter 5, I will attempt to discuss in more depth how these results can be reconciled. For now, our interim conclusion for Study 2 is that both social motives and causal understanding should be taken into account in explaining overimitation in 5-year-olds.

4.3 Study 3 - Minimal Group and Gender Influences on Overimitation

High-fidelity imitation, which results in overimitation if irrelevant actions are included in the demonstrated action sequence, is proposed to serve a crucial function in the transmission of cultural knowledge, including social norms and rituals (Legare, 2017; Nielsen & Tomaselli, 2010). It is proposed that social conventions are a means to affiliation with group members and lead to in-group cohesion (Legare & Nielsen, 2015). One way to accomplish this goal is to behave similarly to in-group members. Therefore, it is unsurprising that transmission of rituals and norms is higher within groups than between groups (Zucker, 1977). Belonging to the same group might increase children's social motivations and make them sensitive to culturally relevant knowledge, such as rituals and norms if they belong to the same group. If overimitation is one of the driving mechanisms in the transmission of cultural knowledge, one of the instruments that enables us to transmit social norms and rituals (Kenward, 2012; Keupp et al., 2013; Legare, 2017), it should be sensitive to group membership.

In Study 3, we investigated influences of two different types of groups on 5-year-olds tendency to overimitate: (1) an artificially formed group and (2) the enduring societal group gender. For artificial group allocation we adopted the classic minimal group paradigm (Dunham, Baron, & Carey, 2011; Spielman, 2000; Tajfel & Turner, 1986; Tajfel, Billig, Bundy, & Flament, 1971) with members of the same team wearing identical jerseys. To test the relevance of gender group-membership, we used action demonstrators of different sex and counterbalanced the children's and experimenter's sex. Again, we used a two-phase paradigm, with the inefficient strategy demonstrated first and the efficient demonstrated second. This led to two combinations of in-group vs. out-group membership of the inefficient and efficient demonstrators: (a) The inefficient demonstrator (Phase 1) was an in-group member and the efficient demonstrator (Phase 2) was an out-group member or (b) the inefficient demonstrator (Phase 1) was an out-group member and the efficient demonstrator (Phase 2) was an in-group member.

If we assume that social motivations increase the urge to behave similarly to in-group members, theories suggesting a strong role of social motives for overimitation predict increased overimitation of in-group members compared to out-group members for both kinds of groups in Phase 1. For Phase 2, we predicted that children would maintain high levels of irrelevant actions when the efficient strategy was demonstrated by an out-group member, but that they would adopt the efficient strategy when it was demonstrated by an in-group member. Causal explanatory models (e.g., Lyons et al., 2007, 2011; Whiten et al., 2009) would predict that children stop overimitating when they discover the irrelevancy of the actions, regardless of group membership.

Schleihauf, H., Pauen, S., & Hoehl, S. (2018). *Who's on my team? Minimal group and gender influences on overimitation.* Manuscript submitted for publication.

Results of Study 3 show that for the artificially formed groups, it did not matter whether an out-group or an in-group demonstrator presented either strategy. Contrary to our expectations, children overimitated (mostly irrelevant actions that involved contact with the puzzle box) equally often, whether an artificial in- or out-group demonstrator demonstrated the inefficient strategy during Phase 1. Moreover, children did not switch to the efficient strategy, even when this strategy was demonstrated by an in-group demonstrator during Phase 2. This was quite surprising, since in Study 1, when we used the same paradigm without the grouping procedure, children adopted the efficient strategy after it was communicatively demonstrated. Neither classical social explanatory models nor causal explanatory models are sufficient to explain these results. One possible explanation is that an external factor, namely the preceding group formation process, not the actual artificial group membership, had an influence on children's imitation. The team formation process included drawing shirts of a certain color, using verbal group labels and euphorically expressing positive emotions about joint group membership. This process is likely to induce high motivation, a pro-social playful atmosphere and a game-like context. This might have led children to copy irrelevant actions because it made them more sensitive to normative and ritualistic behavior and therefore, encouraged them to continue to overimitate. Future research is necessary to investigate these ideas further.

For gender groups, we found a significant interaction between the gender of the child and gender of the inefficient demonstrator. In Phase 1, boys and girls overimitated above baseline level regardless of whether the irrelevant actions were demonstrated by a male or a female demonstrator. In Phase 2, boys continued to overimitate regardless of the efficient demonstration being demonstrated by a male or a female demonstrator. However, girls continued to perform irrelevant actions if the efficient demonstrator was male, but they switched to the efficient strategy if the efficient demonstrator was female. This result is better explained by social explanatory models than by causal explanatory models. If social motives are interpreted as behaving similarly to gender in-group members, especially girls seem to be highly socially motivated to overimitate. However, the external factor of a playful setting should also be taken into account when looking at the gender group influences. It is possible that boys continued to overimitate in Phase 2 regardless of the model's gender, because they were more sensitive to this playful context. Boys seem to be more competitive than girls (Gneezy & Rustichini, 2004; Sutter & Rützler, 2015). The playful context and forming teams might have triggered competition and led to more persistent overimitation in boys.

These findings highlight that contradicting findings in overimitation research could be due to varying external factors, such as the gender of the demonstrator, but also the context created by experimental settings or manipulations. Such factors should be taken into account when planning and interpreting research on overimitation.

In the following, I would like to focus on what we can learn about the underlying motivations of overimitation when looking at the results of Study 1, 2 and 3 together.

5. WHAT ARE OUR MOTIVATIONS TO COPY UNNECESSARY ACTIONS? – THE DUAL-MODE MODEL FOR OVERIMITATION

Recent explanatory models for overimitation can be roughly divided in social accounts and causal accounts. Social accounts (Kenward et al., 2011; Nielsen & Blank, 2011) state, that children imitate irrelevant actions to follow a social rule or to affiliate with another person and therefore have social motivations. In line with this, Over and Carpenter (2012) say that children overimitate when they have social motivations and selectively imitate when they have goal-directed motivations. Accordingly, children overimitate or do not overimitate, depending on their goals in specific situations. By contrast, causal accounts state that children overimitate when they assume that a demonstrated action is causally necessary (e.g., Lyons et al., 2007, 2011) or when they do not question their necessity (Whiten et al., 2009). On this account, children are consistently conceptualized as having goal-directed motivations. Whereas social accounts imply that children recognize that the demonstrated actions are irrelevant, the causal models imply that children do not understand or do not question the irrelevancy of the actions.

Why did children overimitate in our studies? First, I would like to focus on Phase 1 of the conditions in which the inefficient strategy was presented first (Study 1, Study 2, Experiment 1 of Study 3), since this phase is comparable to other overimitation studies in that children only saw a single inefficient demonstration.

In Study 1, 2 and 3, we find that children robustly overimitate after an initial inefficient demonstration. Even in an experimental setup that we thought would encourage them to omit inefficient actions, e.g. when they were demonstrated by a non-communicative or an out-group demonstrator, children overimitated. Boys and girls overimitated in Phase 1 regardless of whether the inefficient model was male or female or whether that model was communicative or not. When children observed the inefficient strategy in Phase 1, their overimitation seemed to be independent of contextual changes. Possible explanations why other studies found context dependency after an initial inefficient demonstration will be discussed in Chapter 5.1.

Whereas overimitation rates in Phase 1 were consistent across different conditions, overimitation rates in Phase 2 varied across different conditions. Phase 2 of these conditions added a new component compared to other overimitation studies. In this phase, children observed how the reward could be retrieved efficiently and were given a second chance to solve the task. In this phase, children's imitative behavior varied across the different experimental manipulations. Children preferentially switched to an efficient strategy when it was demonstrated communicatively and continued to overimitate if the efficient strategy was demonstrated non-communicatively. Similarly, girls stopped overimitating if the efficient strategy was demonstrated by a female model. These results convey the impression that after children learned that there are multiple strategies available, likelihood that they will flexibly switch strategy is context-sensitive.

One explanatory model alone cannot explain these results. Whereas social models and Over and Carpenter's theory (2012a; 2012b) can explain the variations in Phase 2, they are insufficient to explain robust overimitation rates in Phase 1. For Phase 1 of our studies, models focusing on children's causal distortion seem to be the best explanation to explain children's robust overimitation. It seems likely that in Phase 1 children overimitate because they do not recognize or do not question the irrelevancy of demonstrated actions. However, this explanation cannot hold true for Phase 2. Since we found in some conditions that children overimitated even after observing the efficient strategy, causal distortion cannot be the reason why they did so. Therefore, children's motivations to overimitate in Phase 1 are likely to differ from their motivations to overimitate in Phase 2.

To explain the findings of Phase 1 and Phase 2 of our experiments, I would like to propose a new explanatory model (see Figure 2), that combines Whiten's "copy first – refine later" approach (Whiten et al., 2009) and Over and Carpenter's approach (Over & Carpenter, 2012a; 2012b) focusing on social and learning goals leading to different copying behavior. My explanatory model contains two different modes of copying. One mode I will refer to as *blanket copying* (see also Whiten et al., 2009). In this mode, irrelevant actions are copied independent of contextual differences. While copying in a blanket fashion, children copy irrelevant actions without questioning their necessity. However, in contrast to the automatic causal encoding theory by Lyons et al. (2009, 2011) this does not mean that overimitation is unavoidable. Furthermore, it does not mean that children are unable to understand the (missing) causal relations of these actions to the goal. Referring to Whiten et al. (2009), from an evolutionary perspective it seems quite useful to copy actions that are somehow associated with success (not necessarily causally), without questioning them. In most instances, there is not much to lose by copying all actions that could potentially lead to success. On the contrary, there might even be beneficial reasons for performing these actions which cannot be understood from the point of view accessible at a given time. Therefore, instead of asking the question 'Why do children imitate?' in the stage of blanket copying, we should rather ask 'Why not?'.

After the demonstration of the efficient strategy, we found variety in children's overimitation. Therefore, I propose that children's motivations in this phase were different. If disclosing the irrelevancy of the demonstrated actions, children's focus is directed to an alternate efficient option to reach the desired goal. Then, they can actively decide if they would like to copy the demonstrated irrelevant actions or not. When children become aware of their choice of action, their copying becomes more reflected. That is why I will refer to the second mode as *reflective copying*. In the mode of reflective copying, copying of irrelevant actions seems to be context depended. Therefore, the model of Over and Carpenter (2012a; 2012b) applies to the mode of reflective copying. As mentioned above, they distinguish between: (a) "learning goals," that lead to selective imitation based on functional considerations; (b) "social goals," which motivate children to imitate faithfully and (c) a combination of both, which focus children's attention on "how" something is typically done. I would like to add another possible goal to the reflective copying mode: an entertainment goal. In a playful context, children could copy irrelevant actions just because it is fun to perform these actions. If irrelevant actions are highlighted, for example through communication (Study 1), gender group membership (Study 3), a playful (Study 3, Nielsen, Cucchiaro, & Mohamedally, 2012a) or a normative context (e.g., Legare et al., 2015), children tend to overimitate even after having seen a more efficient solution, whereas they prefer to omit irrelevant actions in a more goal-directed context (e.g., Legare et al., 2015). Social, instrumental learning and entertainment goals should not be understood as being exclusive. I assume they can be present at the same time. For example, children could copy an irrelevant action because they think it is a rule to do so and because they enjoy performing them. However, if the actions were less entertaining, they might decide not to follow the apparent rule. Furthermore, imitating itself can be entertaining, but a playful context can also increase the salience of the social function of over-imitation (see also Nielsen et al., 2012a). Whereas I think children are aware of their choice of action, I think they do not necessarily have to be aware of the underling motivations of their action choices. Even if children copy to strengthen social bonds, they are probably not always able to express such motivations.

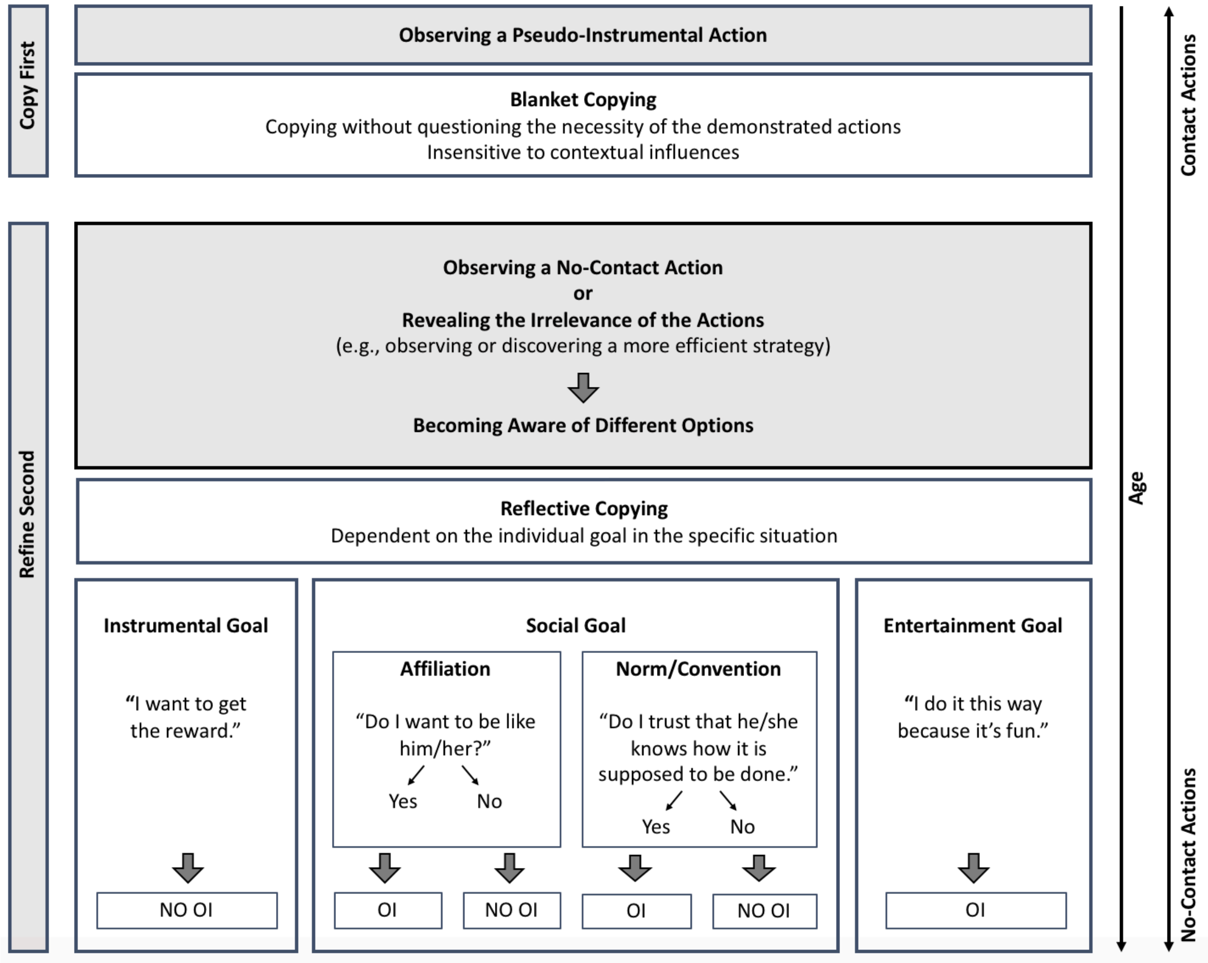

Figure 2. The dual-mode model of (over)imitation. (Questions for instrumental and social goals are exemplary and do not necessarily represent conscious decision processes).

This dual-mode model of (over)imitation is also in line with the dual process theory (e.g., Evans, 2003; Kahneman, 2002; Strack & Deutsch, 2004). According to this theory human behavior is shaped by two systems. The first is referred to as intuition, heuristic or impulsive system, which is driven by immediate feelings, triggered by our environments and elicits automatic behavioral decisions. According to the authors, this system requires little or no cognitive engagement. It is quite likely that this system is active during blanket copying. Since blanket copying is associated with uncertainty about the irrelevancy of demonstrated actions, it is probably less sensitive to external influential factors, such as the demonstrator's characteristics (e.g., communication, group membership), which possibly would be considered in situations in which more cognitive engagement is encouraged. It is possible that cognitive load, time pressure or other factors that favor a less cognitively demanding strategy trigger blanket copying. The other system of the dual process model is referred to as reflective or reasoning system, which is supposed to be driven by our knowledge about values and facts and generates goal-directed behavioral decisions. This system requires cognitive engagement. I assume that this system is active during the second mode of overimitation – reflective copying. Due to the cognitive demand of reflective copying it is likely that this imitation mode is highly sensitive to external but also internal influencing factors. For example, if blanket copying was triggered by cognitive load and time pressure, copying can become more reflected when cognitive load and time pressure decrease.

I assume that there are many factors that can trigger reflective copying. Demonstrating an efficient solution to the problem is one of them. Reflective copying could also be triggered through e.g. exploration, innovation, perhaps through a contemplating personality or through a change of context (e.g., reduction of cognitive load or time pressure or if the performance of irrelevant actions becomes costly). Furthermore, I suggest that whether children copy in a blanket fashion or reflectively can be influenced by the type of irrelevant action they observe. In the following section I would like to describe different types of irrelevant actions and their possible influence on children's overimitation.

5.1 Different Irrelevant Action Types

Even though we did not find contextual differences following the initial demonstration phase in our studies, other overimitation studies have found effects of context manipulations on overimitation after initial inefficient demonstrations (e.g., Keupp et al., 2013; Legare et al., 2015). According to the dual-mode model, it is likely that in these studies such effects were found because children copied reflectively (even though they had no efficient demonstration), whereas they copied in a blanket fashion in after the initial inefficient demonstration in our experiments. What could be the reason for blanket copying after the initial demonstration in our studies and for reflective copying after the initial demonstration in other studies?

I suggest that these differences are due to different characteristics of the irrelevant actions demonstrated in these studies. Since different action characteristics can influence whether actions tend to be perceived as instrumental or conventional (Boyer & Liénard, 2007; Bulbulia & Sosis, 2011; Clay, Over, & Tennie, 2018; Kapitány & Nielsen, 2016; Legare & Souza, 2012; Rossano, 2012; Taniguchi & Sanefuji, 2017), I assume that different action types are (over-)imitated for different reasons. If we have a closer look at the actions that were copied with the highest rates in our studies, we find that *contact actions* (actions that involved contact with the puzzle box) were copied much more often than *no-contact actions* (actions that do not involved contact with the puzzle box). This finding is in line with other studies on overimitation. For example, it was found that children imitated irrelevant actions that were performed on an object which were physically connected to the puzzle box with the reward with much higher rates, especially if these actions included a tool, compared to actions that were performed on a physically disconnected object or on the own body (Lyons et al., 2007; Taniguchi & Sanefuji, 2017).

However, it should be mentioned that the experimental settings and instructions in these studies created a context which is more instrumental than conventional. This also applies to our studies. Studies in which a more conventional or normative context was created found imitation of contact actions as well as no-contact actions (e.g., Clay et al., 2018). Interestingly, the preference for contact actions seem to differ between different age groups. Four-year-olds seem to preferentially copy contact actions over no-contact actions, whereas six-year-olds copied no-contact actions as well as contact actions (Clay et al., 2018). Imitation of no-contact actions was especially high for the older children if these actions were demonstrated in a normative context. Accordingly, it seems that older children are more willing to copy norms, conventions or rituals. It was found that actions which are clearly goal-demoted, meaning it is unclear why the demonstrator is motivated to perform them, is an important feature of rituals (Nielsen, Kapitány, & Tomaselli, 2018). It is probably easier for no-contact actions than for contact actions, to recognize them as being goal demoted. If older children are more sensitive to norms and rituals this could be one of the reasons why they copy not only contact, but also clearly goal demoted no-contact actions. Therefore, I assume that no-contact actions tend to lead to reflective copying. Younger children are probably less sensitive to rituals and norms and rather copy actions that potentially have a causal effect. The probability that an action has a causal effect is higher for contact than for no-contact actions. This could be the reason why younger children preferentially copy contact actions over no-contact actions. It could also be that recognizing if a contact action is causally relevant or irrelevant might be more challenging for younger children. Therefore, it is possible that we observe the same behavior in younger and older children. However, overimitation in younger and older children can have different underlying motivations.

The consistent overimitation rates after the initial inefficient demonstration in our studies could be due to the characteristics of the irrelevant contact actions we demonstrated. Whereas contact actions in other overimitation studies mostly involve superficial tapping or circling actions on the surface of the puzzle box (Nielsen et al. , 2012a; Nielsen, Moore, & Mohamedally, 2012b), contact actions in our studies were performed on permanent attachments to the puzzle box (pushing the non-functional lever and pushing the non-functional button). Children might be familiar with similar actions from everyday life (e.g., pushing a button to a turn on a light) that are usually associated with an effect. Even if demonstrated actions do not have an instrumental effect on the reward, they are similar to actions that usually have an effect. Therefore, I will refer to them as *pseudo-instrumental actions*. It is likely that it is challenging to recognize pseudo-instrumental as being irrelevant (especially for younger children), which could be the reason why such actions lead to blanket copying. If we look at the actions that were demonstrated in the original study by Horner and Whiten (2005), we see that some of the irrelevant actions they demonstrated can also be categorized as being pseudo-instrumental. For example, they demonstrated removing a bolt defense and inserting a stick into the manufactured whole. Both actions were performed on permanent attachments or manufactured properties of the reward containing puzzle box. This distinguishes them from superficial contact actions.

Contact actions that involve physical contact with the puzzle box but are only superficial and not pseudo-instrumental, might be easily recognized as being irrelevant by older children and adults, whereas it might be more challenging for younger children. Accordingly, these age differences in overimitation rates should be greater for superficial contact actions and smaller for pseudo-instrumental actions. I predict that superficial contact actions are copied more by younger children and less by older children and pseudo-instrumental actions are copied to equal rates by older and younger children (but maybe less by adults).

As mentioned above, we found in all our studies that children copied pseudo-instrumental actions to a much higher extent than they copied no-contact actions. Even if context was not intentionally manipulated in our studies, the context which was created was instrumental: Children's focus was always guided to the goal of the task (i.e. retrieving a reward), and they were instructed to "retrieve a reward however they liked", which was found to lead to lower over-imitation rates, compared to the instruction "It's your turn" (Moraru, Gomez, & McGuigan, 2016). Given this instrumental context, it is quite surprising that we found consistent overimitation of pseudo-instrumental actions. Theories stating that a ritual and conventional context activates children's social goals, whereas an instrumental context activates learning goals (Clegg & Legare, 2016b; Over & Carpenter, 2012a; 2012b) would have predicted that all types of irrelevant actions would be omitted completely, especially if social pressure was minimized (demonstration by a non-communicative/out-group demonstrator, child alone during test phase). However, we found that no-contact actions were omitted, whereas pseudo-instrumental actions were copied. This finding supports the idea that children perceive pseudo-instrumental actions differently.

Taken together, it seems important to distinguish different action types in overimitation studies. Whereas children may not question the irrelevancy of pseudo-instrumental actions, they do recognize or at least question the irrelevancy of no-contact actions. Not considering these differences may lead to contradicting findings.

Action type seems to be one of the key triggers for blanket or reflective copying. If an action is pseudo-instrumental it tends to be copied in a blanket fashion; if an action does not involve physical contact with the puzzle box it tends to be copied reflectively. However, action type is not the only factor influencing overimitation. Especially in the mode of reflective copying, many external and internal factors play a role when deciding whether to imitate certain actions or not.

5.2 Factors Influencing Blanket and Reflective Copying

Blanket and reflective copying differ regarding the degree to which they are malleable to external and internal factors. Blanket copying is quite insensitive to external influential factors. If children think they have to perform an action to achieve a certain goal, they will perform that action if they want to achieve that goal, regardless of most external influences. However, some external factors, such as cognitive load, time pressure or other factors that favor a less cognitively demanding strategy might even enhance blanket copying.

The amount of information that can be processed during reflective copying is much higher, which increases possible influences of external and internal factors. Going back to the research of Albert Bandura (1986; 1999; 2001; 1971), a well-established finding in social psychology is that behavior, internal personal factors (e.g., beliefs and personality), and external social and environmental factors interact reciprocally. Especially when we are aware of our choices, we match our behavior with internal factors, such as our thoughts and values, and also with external factors, such as our surroundings, the present context or the behavior of other people. When we copy reflectively, we are aware of having different options regarding how to behave. Therefore, it is likely that we match our decision to copy certain actions or to omit them with internal and external factors. If we are aware of our choices, what factors influence whether we overimitate or not?

In recent overimitation literature, influences of a variety of external and internal factors on imitation of superficial contact actions have been reported (see Figure 3). External factors that have been found to influence our tendency to overimitate (during reflective copying), are the model's characteristics, characteristics of the task itself and characteristics of experimental settings and environments. Model characteristics that seem to influence overimitation are for example, whether the model acts communicatively (Study 1), whether the model is an adult, a peer or a puppet (McGuigan & Robertson, 2015; Wood et al., 2016; Wood, Kendal, & Flynn, 2012), whether the model is male or female (Study 3) or whether the model is a person of high status, such as the child's head teacher (McGuigan, 2013). Task characteristics that have been shown to influence children's overimitation are, for example, action type (see Chapter 5.1), whether tools are used to perform irrelevant or relevant actions (Taniguchi & Sanefuji, 2017), whether irrelevant actions are executed by hand or an unusual body part (Clay et al., 2018), whether start- and end-state of the task are equal or different (Watson-Jones et al., 2014), or whether task instructions create a conventional or instrumental framing (Clay et al., 2018; Clegg & Legare, 2016a; Keupp et al., 2013; Moraru, Gomez, & McGuigan, 2016). Influencing characteristics of the experimental setting are for example warm-up-games that are played before the actual experiment starts. Games that prime ostracism have been shown to increase children's imitation (Over & Carpenter, 2009; Watson-Jones et al., 2014). Similarly, influences of cooperative or competitive warm up games on prosocial behavior are reported (Ewoldsen et al., 2012; Greitemeyer & Mügge, 2014). Therefore, it seems likely that such warm-up games influence children's overimitation. Keeping in mind that such minor manipulations can affect overimitation, it seems even more likely that the game-like context in Study 2, which was a by-product of the group manipulation, influenced children's tendency to overimitate and to continue to overimitate. A factor that has not yet been experimentally investigated is the influence of the general environment in which an experiment takes place. Some studies are conducted in university laboratories (our studies), kindergartens (McGuigan & Burgess, 2017), science museums (e.g., Clay et al., 2018) or schools (McGuigan & Burgess, 2017). It is possible that certain environments trigger certain modes, which could influence our tendency to overimitate. Taken together, while copying reflectively, many external factors influence whether we overimitate or imitate selectively. How complex these decisions are, becomes apparent when we consider that these external factors can not only interact with each, but also with internal factors and our behavior.

Compared to the influence of external factors, the influence of internal factors on overimitation has been investigated far less frequently. However, it is important to consider that external or internal factors do not operate in isolation: they also interact in influencing our behavior. How we perceive external influences is dependent on internal factors, such as prior experiences, knowledge, values, temperament, character and our goals in specific situations. For example, it is likely that children with a greater need for social recognition are more likely to overimitate when a communicative model demonstrates irrelevant actions. It has been found that the tendencies to imitate (irrelevant) features of goal-directed actions is higher in extraverted children (Fenstermacher & Saudino, 2016; Hilbrink, Sakkalou, Ellis-Davies, Fowler, & Gattis, 2013). There are also findings that raise the question of whether "imitativeness" – people's propensity to imitate - is itself a personality trait. One finding in support of this idea is that some children are more imitative than others, and these individual differences transcend contextual influences (Yu & Kushnir, 2015).

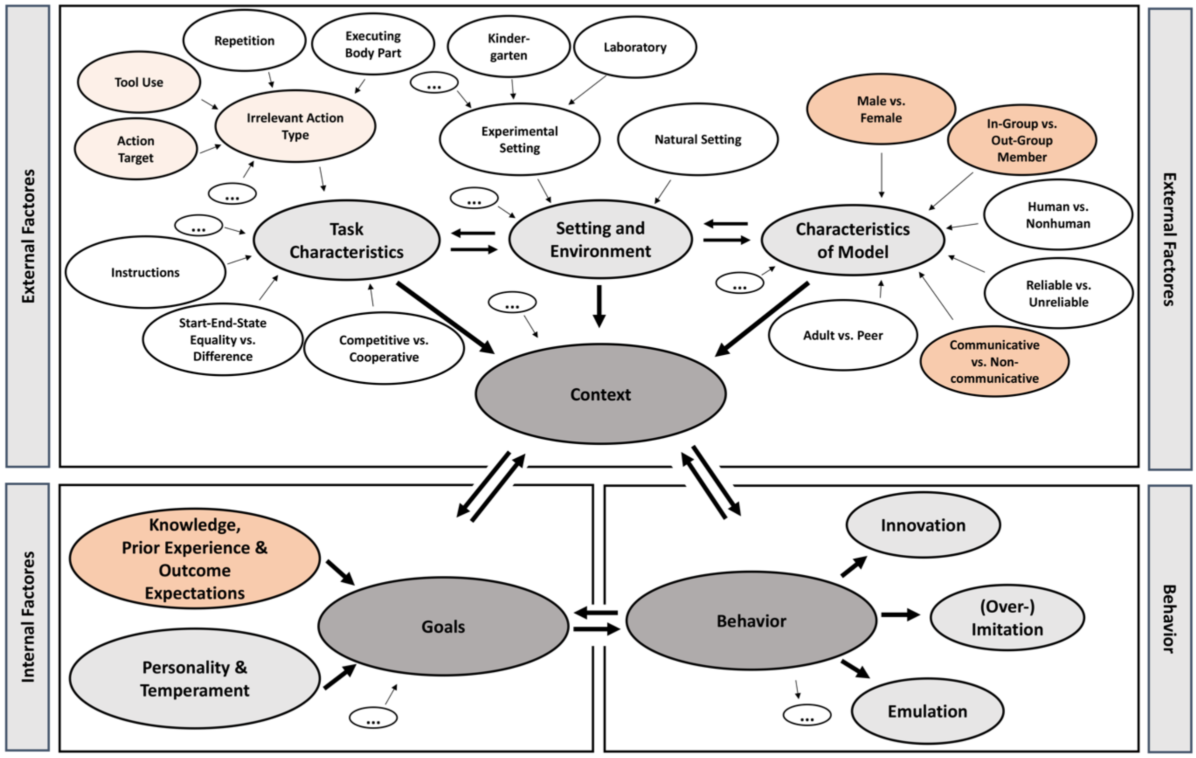

Figure 3. Application of Bandura's Social Cognitive Theory (Bandura, 1986; 1999; 2001; 1971) on reflective copying. This figure lists internal and external factors that have been investigated in overimitation research. Factors considered in the studies of this dissertations are highlighted in orange (dark = experimental manipulated, light = counterbalanced).

Now that we have a comprehensive picture on what factors might influence reflective copying and increase children's tendency to overimitate or copy selectively, I would like to discuss the results of Experiment 2a and 2b of Study 2. In these experiments, children already learned in Phase 1 how to retrieve a reward efficiently. Therefore, in contrast to other studies, they entered the mode of reflective copying from the beginning. Especially for Experiment 2b, we expected children to switch from an efficient to an inefficient strategy, because only the inefficient strategy was demonstrated communicatively. We predicted that, in the mode of reflective copying, social emphasis on the inefficient strategy would lead to overimitation. In contrast to our expectations, most of the children did not switch to an inefficient strategy. However, even if the mean overimitation level did not exceed baseline level, it should be mentioned that 11 out of 28 children chose to perform at least one irrelevant action after the inefficient demonstration (Experiment 2b). How can the absence of overimitation despite social emphasis of the inefficient strategy be explained?

As illustrated above, a variety of factors can influence children's decision to overimitate or to copy selectively. Therefore, there are also a variety of potential explanations as to why the emphasis of the inefficient strategy through communication was insufficient to elicit higher overimitation rates in Experiment 2a and 2b of Study 2. One explanation is that the demonstration of the efficient strategy first influenced the general context of the experiment. Since children's focus was directed to the goal, namely getting a reward, from the very beginning, they perceived the context of the experiment as instrumental. Another explanation is that children's past behavior influenced their future behavior. If children acted efficiently in the past (Phase 1), there are (at least) two good reasons for doing so in the future: (1) They have been successful with this strategy before, and (2) it is the most efficient strategy. If children acted inefficiently in the past (Phase 1), there is only one good reason for sticking with this strategy and one good reason for switching to a more efficient strategy: They have been successful with the inefficient strategy and switching strategies could feel like admitting that the first strategy was the worse option on one hand, but on the other hand, they could reach the goal more efficiently. A third possible explanation is that, in the mode of reflective copying, individual differences between children emerge more strongly. This could have split our sample into children with pronounced social needs (children who overimitated) and children with a lower need for social attention (children who acted efficiently), for example. These many possibilities demonstrate that, during reflective copying, the decision to imitate or not is not only dependent on e.g. the communicativeness of the model, but also on a multitude of external and internal factors and their interactions.

6. CONCLUSION

Let's return to the bubblegum machine example from the introduction. Imagine you are five years old and you are with your parents at a fair in a foreign country, you have a craving for bubblegum and find an unfamiliar looking vending machine and your parents give you some coins to get some bubblegum. You do not know how to operate the machine, but you are in luck: you get to observe another person use the machine in front of you. This person taps on top of the machine three times. She pushes the lever on top of the box back and forth. She inserts a coin and taps on the top three times again. Finally, she turns the wheel, withdraws her bubblegum from the machine, and leaves. How do you operate the machine?

In this dissertation I proposed a novel dual-mode model of overimitation. According to this model it is likely that you would push the lever back and forth, insert the coin and turn the wheel. While you may conclude that the tapping did not achieve anything; you might not be completely sure about the functionality of the lever. The machines in your home country do not have this kind of lever, but there might have been a reason why the other person pushed it, and after all, you have little to lose by using the lever. In this situation, even without any social pressure, it is quite likely that you would imitate the actions which are similar to actions that are associated with an effect in everyday life.

However, what would have happened if the person who got the bubblegum shortly before you had stayed and watched. Or, what would have happened, if your parents told you the night before that it is important to respect rituals and traditions of people in this foreign country? Would you also have tapped on the machine? According to the dual-modes model, many factors could influence whether you copy the actions which seem to have no causal relation to getting the bubblegum. Social motivations might be one of the main reasons to copy such actions.

The dual-modes model of overimitation, with the mode of blanket and the mode of reflective copying, provides a new explanatory framework for answering the puzzling question 'Why do we overimitate?'. According to the dual-modes model, children that do not question the necessity of the actions copy them in a blanket fashion, while children that do question them copy reflectively. This model emphasizes the different context sensitivity of blanket and reflective copying. Whereas blanket copying seems to be insensitive to contextual influences, reflective copying seems to be sensitive to effects of external and internal factors combined with the effects of prior behavior and their interactions. With this model, it becomes clear that there is no single explanation for overimitation. Conversely, motivations behind overimitation seem to be various and highly complex. It remains the task of future research to unravel this complexity.

Future research should for example, focus on revealing possibly differing motivations for overimitation in different age groups. It is important to find out whether children of different age groups question which kind of actions do and do not have causal effects on desired outcomes. Furthermore, it should be investigated if factors like cognitive load and time pressure trigger blanket copying, if copying could become more reflected when cognitive load and time pressure decrease and if overimitation then persist in normative but not in instrumental contexts. It would also be interesting to investigate if the tendency of apes not to imitate non-functional actions changes when they get familiarized with a variety of actions from one type resulting in effects (e.g., install differently looking levers in the enclosure that lead to different effects), so that the demonstrated irrelevant actions (e.g., pushing a non-functional lever) become pseudo-instrumental from the ape's perspective.

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LIST OF FIGURES

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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.

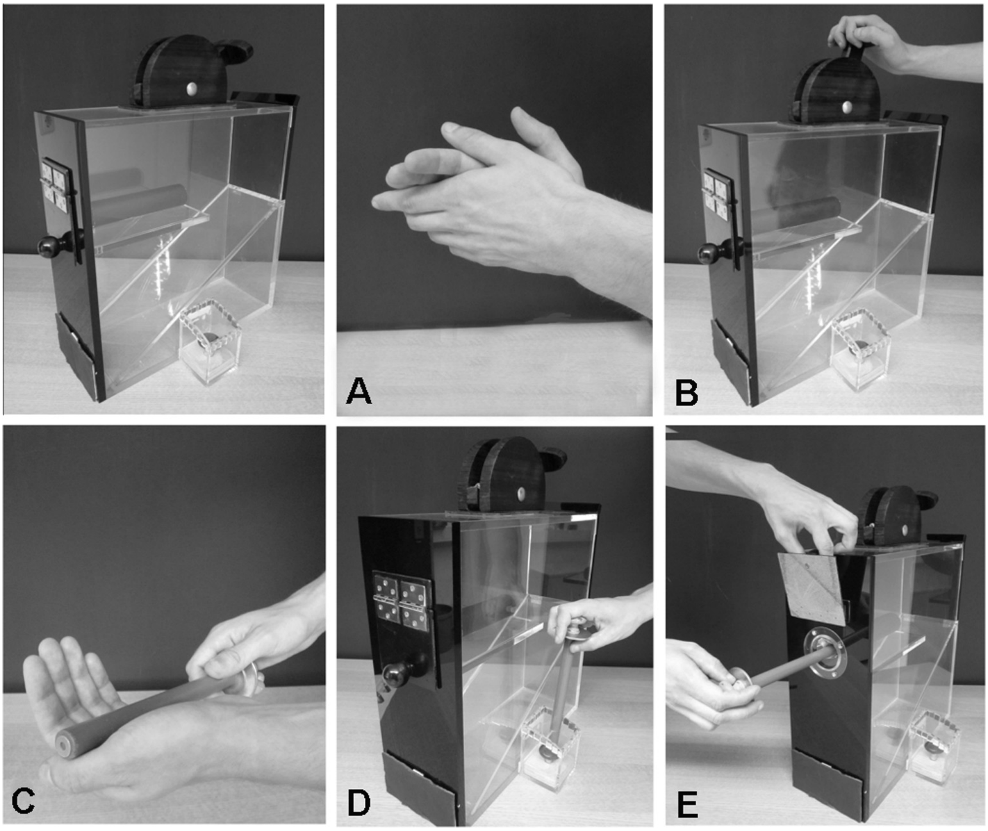

Fig. 1. The container and actions performed by the experimenters. Tokens were placed in the opaque tube within the transparent container. The inefficient demonstration consisted of four irrelevant actions (A–D) and one relevant action (E). The efficient demonstration consisted of only the relevant action.

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 pedagogical 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).
** $p < .001$.

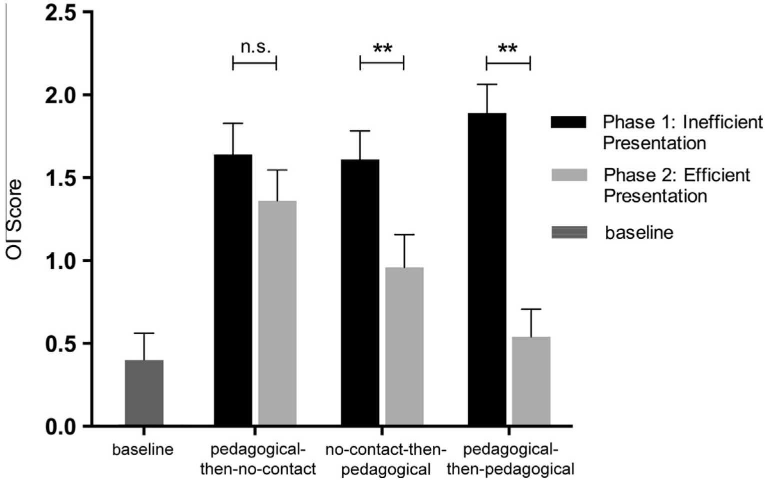

Fig. 2. Mean Overimitation scores (OI scores) in each of the experimental conditions and in the baseline condition. Error bars indicate standard errors. Asterisks indicate significant differences in mean OI scores (**$p < .001$; n.s., not significant).

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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II. MANUSCRIPT

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Contrasting Social and Cognitive Accounts on Overimitation: The Role of Causal Transparency and Prior Experiences

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Three experiments (N = 100) examine the influence of causal information on overimitation. In Experiment 1, a transparent reward location reveals that the reward is unaffected by nonfunctional actions. When 5-year-olds observe an inefficient and subsequently an efficient strategy to retrieve a reward, they show overimitation in both phases—even though the reward is visible. In Experiment 2, children observe first the efficient then the inefficient strategy. The latter is always demonstrated communicatively, whereas the efficient strategy is presented communicatively (2a) or noncommunicatively (2b). Regardless of whether the efficient strategy is emphasized through communication or not, most children do not switch from the efficient to the inefficient strategy. Depending on the situation, children base their behavior on social motivations or causal information.

Imitation is a powerful and adaptive learning strategy which involves copying an action sequence performed by another person. Children are enthusiastic imitators, imitating actions that are obviously nonfunctional to achieve the goal of an action sequence. This behavior is sometimes referred to as "overimitation" (e.g., Horner & Whiten, 2005; Lyons, Young, & Keil, 2007; McGuigan, Makinson, & Whiten, 2011; McGuigan, Whiten, Flynn, & Horner, 2007; Wood, Kendal, & Flynn, 2012).

In a typical paradigm designed for studying overimitation, participants first see how an interactive partner retrieves a reward from a container using a combination of nonfunctional and functional actions. After observing the model, children (McGuigan & Whiten, 2009; Nielsen & Tomaselli, 2009) as well as adults (Flynn & Smith, 2012; McGuigan et al., 2011) tend to copy both functional actions (e.g., opening a lid to retrieve a reward) as well as nonfunctional actions (e.g., tapping on the box before opening it). Crucially, nonfunctional actions are not performed when participants operate the container without prior demonstration (e.g., Hoehl, Zettersten, Schleihauf, Grätz, & Pauen, 2014; Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons et al., 2007).

Children's tendency to overimitate is often explained by social factors such as the desire to affiliate with others (Nielsen & Blank, 2011), the sensitivity to teaching signals (Gergely & Csibra, 2006), or normative or conventional pressure that might support learning of social norms and rituals (Kenward, Karlsson, & Persson, 2011; Kenward, 2012; Keupp, Behne, & Rakoczy, 2013; Legare & Nielsen, 2015). For example, Kenward (2012) had found that 3- to 5-year-olds observe an experimenter perform functional as well as nonfunctional 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 nonfunctional actions. Thus, children apparently accepted modeled nonfunctional actions as normative and, as shown previously in other contexts (Rakoczy, Warneken, & Tomasello, 2008), protested when experiencing violations of these social norms.

Legare and Nielsen (2015) proposed that individuals adopt a ritual stance—that is, attribute a rationale of cultural convention to actions that serve no apparent instrumental reason, resulting in high-fidelity imitation. It is stated that children interpret behavior as instrumental if the physical causality is knowable; if the underlying physical causality

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cannot be understood, children tend to see these actions as socially motivated and interpret them conventionally (e.g., Kapitány & Nielsen, 2015; Legare, Wen, Herrmann, & Whitehouse, 2015; Wilks, Kapitány, & Nielsen, 2016). Thus, actions that are obviously noninstrumental seem more likely to serve a social purpose than actions that have a causal effect. According to Froese and Leavens (2014), overimitation is a highly selective activity by which children pick out behaviors with a meaning that seems causally unintelligible and consider them to be determined by social conventions. Therefore, if overimitation primarily serves a social purpose, it should occur especially when children know that the observed actions have no causal function, that is, when the causal mechanism of the testing object is fully transparent and clearly not relevant for the demonstrated action. In a recent study by Nielsen, Kapitány, and Elkins (2015), preschool children watched an adult experimenter model redundant actions on a box (e.g., tapping the side of it with a tool) after the box had been opened. Later, children reproduced the nonfunctional action even though the box had already been open at the time the actions were performed, and it was thus obvious that tapping it with the tool did not have any effect.

Further support for social theories to explain overimitation is provided by the finding that children sometimes copy nonfunctional actions selectively: They reproduce them in the presence of an inefficient demonstrator who had performed them earlier, but not in the presence of an efficient demonstrator who previously demonstrated only functional actions (Nielsen & Blank, 2011). This has been interpreted as evidence that children's overimitation reflects a desire to affiliate with the respective model.

However, some empirical findings do not support this view: Lyons et al. (2011) found that children refrained from imitating actions that could not possibly have any causal effect on achieving the action goal because they were performed on an unconnected second container. In addition, the findings of Hoehl et al. (2014) suggested that actions not performed directly on the testing object containing the reward (e.g., clapping) were imitated less frequently than actions performed on the container. Thus, actions that cannot possibly have a causal effect on the retrieval of a reward were often omitted.

Based on their results of robust overimitation even in competitive contexts with time constraints, Lyons et al. argued that children automatically encode observed intentional actions as functionally relevant as long as these actions do not violate fundamental principles of causality, such as physical contact. This process has been dubbed *automatic causal encoding* (Lyons et al., 2007, 2011). Others have suggested that children cannot reliably discern the connection between specific actions and outcomes, and therefore imitate all actions performed at the testing object. As a consequence, children should first copy faithfully, as this behavior has proven to be useful in everyday life, but if some of the copied actions turn out to be causally irrelevant, they may be parsed out later on (Simpson & Riggs, 2011; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Following this view, knowledge of the causal mechanism of the testing object or the functionality of a more efficient strategy should in fact reduce overimitation.

Other theories combine causal and social factors to explain the flexibility of children's (over)imitation (Over & Carpenter, 2012). According to Over and Carpenter (2012), a variety of different motives come into play whenever children perceive another person demonstrating a goal-directed action sequence. The authors distinguish between: (a) "learning goals," which lead to emulation or selective imitation based on functional considerations; (b) "social goals," which motivate children to imitate faithfully (in the case that the demonstrated actions were nonfunctional leading to overimitation); and (c) a combination of both, which should also focus children's attention on "how" something is typically done, therefore leading to faithful or even overimitation. Thus, depending on which goals are highlighted by a specific situational or task context, children may imitate or omit nonfunctional actions demonstrated by another person. It follows that causal information may have different effects depending on whether children's social goals or learning goals are predominant in a given situation.

In sum, contrasting hypotheses regarding the effects of causal information on children's imitation of nonfunctional actions can be derived from existing theories to explain overimitation. According to theories focusing on social factors, imitation of nonfunctional actions is more likely to occur if their irrelevance is obvious to the children, because they should infer that the demonstration must have a social purpose and hence be motivated to conform with social norms or assure affiliation. In contrast, accounts focusing on children's causal understanding predict that actions that obviously do not have any causal or functional effects (e.g., because they are not performed on the reward container) should lead to lower imitation rates.

In order to shed a new light onto mechanisms underlying overimitation, the present set of experiments aims at testing these different theoretical accounts by manipulating causal and functional transparency of the task. Two different approaches are used to directly manipulate children's causal and functional knowledge about the task: First, the extent of the testing container's visual transparency (Experiment 1) and, second, children's prior knowledge about how to retrieve the reward most efficiently (Experiment 2). To our knowledge, no research has explored the influence of causal information up to full causal transparency (complete visual transparency of the testing object) and functional transparency (providing the most efficient solution beforehand) on overimitation.

In Experiment 1, we ask whether children imitate nonfunctional actions even when they see that the reward is unaffected by these actions. In Experiments 2a and 2b, we test whether children would switch from an efficient strategy to an inefficient strategy. Experiments 2a and 2b vary in the emphasis of the inefficient strategy. These studies were conducted with 5-year-old children because overimitation is a robust phenomenon at this age (McGuigan et al., 2007) and because we compare data directly with data from a previous study with the same age group (Hoehl et al., 2014).

Experiment 1: Do Children Overimitate Actions That Are Clearly Irrelevant in Causal Terms?

In some previous studies on imitation, availability of causal information was manipulated by using transparent or opaque testing containers (Horner & Whiten, 2005; McGuigan et al., 2007). Results of these studies indicate that 3- to 5-year-olds imitate demonstrated nonfunctional actions regardless of whether causal information was available or not, that is, whether the container was transparent or opaque.

However, most overimitation studies (for an exception see, e.g., Gardiner, 2014) used an opaque reward location to ensure that children could not see the reward before retrieving it (e.g., Berl & Hewlett, 2015; Hoehl et al., 2014; Horner & Whiten, 2005; McGuigan et al., 2007; Nielsen, Tomaselli, Mushin, & Whiten, 2014). In some studies the container itself was entirely opaque and nonfunctional actions were performed on the outside (e.g., Nielsen & Blank, 2011; Nielsen & Tomaselli, 2010). Therefore, children may have inferred that the demonstrated actions affected the reward through some hidden mechanism. Nielsen et al. (2015) used opaque wooden boxes but demonstrated irrelevant actions after the reward-containing box had already been opened to ensure children knew that these actions did not have any causal effect on the reward. As the box was open, one could say the reward location was transparent while the irrelevant actions were performed. The authors found that children copied the redundant actions anyway. However, in this study the demonstrator was present during the child's turn, which likely increased social pressure to act like the model. Furthermore, during demonstration, the relevant action was not performed efficiently, because the experimenter used a tool to open the lid of the box when he simply could have used his hands. Although Nielsen et al. (2015) ensured that children knew that the irrelevant actions did not affect the reward by demonstrating them after the box was already opened, they demonstrated only one strategy including a relevant and an irrelevant action.

To investigate how the visibility of the reward affects children's imitation of nonfunctional actions, we used a task originally introduced by Hoehl et al. (2014) but exchanged the opaque tube containing the rewards for a transparent tube. As long as the tube is opaque, children cannot see the crucial event—how the tool, that is inserted into the tube, connects with the reward. Therefore, they cannot know for sure that the demonstrated irrelevant actions have no bearing for the relevant action. The tube is the crucial part of the apparatus; as long as it is opaque the relative impact of causal and social information on overimitation is hard to discern.

In contrast to the study by Nielsen et al. (2015), children in the current study observed two separate demonstrations, the inefficient and the efficient strategy, whereby the efficient strategy was actually the most efficient way possible to retrieve a token. Further we tried to minimize social pressure by leaving the child alone during the testing phase. Children saw a transparent apparatus with a transparent tube inside, containing rewards (marbles with a magnet attached to them). Therefore, children saw the reward before any action on the apparatus was performed (this was not the case in Nielsen et al., 2015). As in Hoehl et al. (2014), two different experimenters demonstrated two different strategies to retrieve a reward from the box. Experimenter A demonstrated the inefficient strategy, which included a number of additional actions. These actions were clearly nonfunctional and causally irrelevant (Figures 1A to 1D, see description of procedure for more details). At the end of the sequence, the only relevant action was demonstrated: To get a reward, a magnetic rod was inserted into the tube and made contact with a

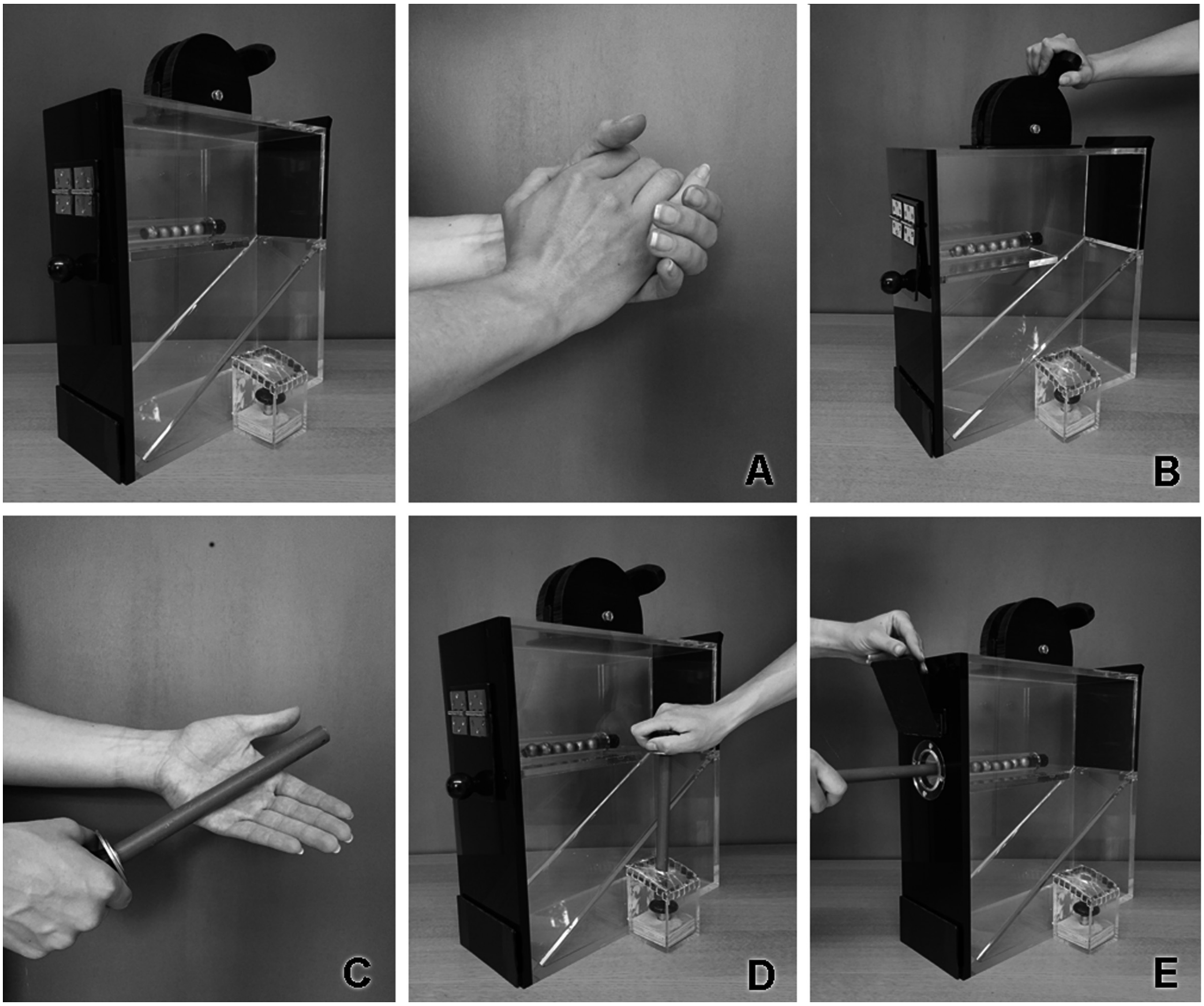

Figure 1. The container and actions performed by the experimenters. Tokens were placed in the transparent tube within the transparent container. The inefficient demonstration consisted of four nonfunctional actions (A–D) and one functional action (E). The efficient demonstration only consisted of the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

marble so both could be pulled out together (Figure 1E). After letting the child retrieve a marble, Experimenter B demonstrated the efficient strategy using only the relevant action (Figure 1E). Then it was the child's turn again. By giving children the opportunity to imitate following each demonstration, we reduced the impact of memory skills on performance and gave children the chance to personally succeed with either strategy.

Pairing the irrelevant actions with a communicative demonstrator represents the way that overimitation is usually induced (e.g., Horner & Whiten, 2005; Nielsen & Blank, 2011). In this experiment, the typical overimitation effect was caused by Experimenter A demonstrating the inefficient strategy in a communicative way (Phase 1), thus increasing the salience of irrelevant actions. Experimenter B performed the efficient strategy without communication (Phase 2). We adopted this design from Hoehl et al. (2014) who found that children continued to overimitate even after watching a noncommunicative demonstrator performing the efficient strategy (but not after watching communicative demonstrations of the efficient strategy). By replicating this procedure, we were able to test whether the initiation of overimitation and its persistence despite the subsequent demonstration of the efficient strategy can be replicated with a transparent reward location. Furthermore, pairing the efficient demonstration with a noncommunicative experimenter allowed the child to merely observe the efficient demonstration, enabling evaluation of the impact of causal and functional information about the task with only minimal social input.

As the tube presented in these experiments was fully transparent, imitation of nonfunctional actions could not be attributed to the opaqueness of the mechanism. We thus enhanced the potential impact of causal knowledge compared to Hoehl et al. (2014) who used an opaque tube in the same paradigm. To test the effect of increasing causal transparency, we compared our data directly with data from Hoehl et al. (2014).

Theories focusing on children's causal reasoning (Lyons et al., 2007, 2011; Whiten et al., 2009) would predict that—in comparison to results obtained by Hoehl et al. (2014)—children should overimitate less when they can see that the reward is unaffected by nonfunctional actions (Phase 1) and that they should stop overimitating after having observed the efficient strategy, that is, having seen that there is no functional reason for performing these nonfunctional actions in order to achieve the reward (Phase 2). In contrast, social accounts would predict that children overimitate even when they can see that the reward is unaffected by nonfunctional actions (Phase 1) because this should underscore the social-normative value of the demonstrated actions and they should continue to do so despite having seen the efficient strategy performed by a noncommunicative model (Phase 2). Experiment 1 will thus reveal to what extent causal and social factors contribute to explaining children's imitative behavior.

As a dependent variable, we assessed the imitation rate for nonfunctional actions following each demonstration phase in comparison to a baseline condition in which another group of same-aged children operated the container without any prior demonstration.

Method

Participants

The study was conducted in a medium-sized German university town. Forty-four 5-year-old preschoolers (22 male; $M = 62.2$ months, $SD = 1.64$) participated. Data were collected between October 2013 and February 2014. In the comparison conditions from Hoehl et al. (2014), forty-three 5-year-olds (opaque tube condition: $n = 28$, baseline condition: $n = 15$, comparison data were collected in June 2012 and July 2013) were included in data analyses. Participants were recruited from an existing pool of children who had taken part in earlier thematically nonrelated studies. Data from the local's registration office were provided to get in contact with the parents for the first time shortly after the children's birth. The parents first received a letter and were contacted over phone a few weeks later. Children were included in this pool after their parents have expressed interest in having their child take part in developmental research. When the children reached the appropriate age for the study, the parents were contacted by phone, and those interested in volunteering brought their children to the university for testing. The majority of the children participating were Caucasian and from middle-class socioeconomic backgrounds. As in the precursor study, children were assigned to one of two conditions: one experimental condition ($n = 28$, 14 male) and one baseline condition ($n = 16$, 8 male). An additional six children were excluded from the final sample because of experimenter error ($n = 3$) or unwillingness to participate ($n = 3$).

Materials

Children were presented a magnetic rod and a clear Plexiglas® (Evonik Performance Materials GmbH; Essen, Germany) container revealing the irrelevance of certain actions performed during the modeling phase of the experiment (see Figure 1). A transparent tube was located 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, which could be pushed using the rod, was attached on the right side. The lever and the button had no functions and were obviously not connected to the tube containing the marbles. Furthermore, we used two cardboard boxes to exchange the tokens for the stickers. One was golden and had a little hole in its lid, through which the tokens could be inserted. The other was heart shaped and contained the stickers.

Procedure

Children were tested individually in a quiet laboratory room. Before entering the testing room, Experimenter A welcomed the child and explained that they were going to play some games together. Parents stayed in a separate room. Sex of children and experimenters was balanced across conditions. Both experimenters were of opposite sex. Each session was recorded on video.

Table 1
Experimental Conditions—Experiment 1

	Phase 1: Inefficient demonstration		Phase 2: Efficient demonstration	
Opaque tube (Hoehl et al., 2014)	Communicative	Test Trial 1	Noncommunicative	Test Trial 2
Transparent tube	Communicative	Test Trial 1	Noncommunicative	Test Trial 2

The study design is summarized in Table 1. In Experiment 1, participants were randomly assigned to either the *transparent tube condition* or to the *baseline condition*. In the transparent tube condition, the inefficient strategy to reach a goal was demonstrated in a communicative context (Experimenter A; eye contact, talking, praising), increasing the salience of the nonfunctional actions, whereas the efficient strategy was presented by an unknown model (Experimenter B) who never talked to the child nor established eye contact. The comparison condition from Hoehl et al. (2014) thus differed only regarding the transparency of the reward location. Children assigned to the baseline condition interacted only with one experimenter, who was communicative and did not demonstrate how to operate the container.

Warm-Up Phase

Experiment 1 started with a warm-up phase. The child played an unrelated competitive game with Experimenter A (i.e., blowing a cotton ball into a goal), who ensured that the child won some tokens to increase motivation for the main task. They were introduced to the concept that the tokens (golden marbles) could be exchanged for rewards (stickers). Experimenter A explained that sticking the golden marbles through the opening of the golden box permitted the child to choose one sticker for each marble from the heart-shaped box. The game was played twice to make the child feel comfortable in the experimental environment.

Introduction of the Container

In the next step, the child was introduced to the transparent container. Experimenter A (same as during warm-up) verbally introduced all 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 get a marble out, you can exchange it for stickers.” The following experimental setup differed between conditions.

Baseline Condition

To establish the baseline performance of the nonfunctional actions, the child was allowed to remove a token without prior demonstration. Experimenter A instructed the child to retrieve a token any way he or she liked and then left the room until: (a) the child had successfully retrieved one token, (b) the child had stopped interacting with the container for at least 30 s, or (c) 80 s had elapsed. Children in the baseline condition did not get a second demonstration and did not get in contact with Experimenter B.

Transparent Tube Condition

In Phase 1, children observed Experimenter A retrieving a token from the container in an inefficient way. After introducing the container, Experimenter A started the game (“Okay. Let’s start. It’s my turn first.”). If necessary, the child’s attention was directed to the demonstration by saying “Watch!” or “Look!” Then, Experimenter A retrieved a token by using the following nonfunctional (Figures 1A to 1D) and functional (Figure 1E) actions: clapping his or her hands (Figure 1A), pushing the lever attached to the top of the container back and forth (Figure 1B), tapping the rod on the palm of his or her hand three times while simultaneously counting out loud to three (Figure 1C), pushing the button attached to the side of the container with the rod (Figure 1D), and finally lifting the flap covering the opening to the tube and removing a marble by using the magnetic rod (Figure 1E). Only the last action was functional to reach the reward. The irrelevant actions were varied systematically regarding their relation to the container; clapping and tapping involved no direct contact with the container, whereas pushing the lever and pushing the button did. Following that, Experimenter A instructed the child to retrieve a token any way he or she liked and then left the room (Test Trial 1). After the child had successfully retrieved a token, Experimenter A returned to the room and helped to exchange the token for the reward (i.e., stickers). Following that, he or she sat down at a desk and pretended to write something down facing away from the scene, not interacting with anyone in the room. This was done to ensure that a person familiar to the child was present when Experimenter B entered the room.

In Phase 2, children observed how Experimenter B entered the room without contacting the child or Experimenter A but expressing his or her intention, "I want stickers and am going to get me a golden marble now," implicating that he or she knew about the way how a marble could be exchanged for stickers. Next, he or she retrieved a token using only the efficient strategy (i.e., showing the functional action only, see Figure 1E). Then he or she exchanged the token for stickers without any help of Experimenter A (who was still pretending to write something down) and left the room. Subsequently, Experimenter A returned to the child, saying that it was his or her turn again to retrieve a token any way they liked. Following that, Experimenter A left the room, thus leaving the child alone during testing phase (Test Trial 2). Once the child had retrieved a token, Experimenter A returned and helped the child exchanging it for stickers.

Coding and Reliability

The number of nonfunctional actions (see Figures 1A to 1D) children imitated during the test phase served as dependent measure. This individual *nonfunctional action score* (NFA score) delivers values from 0 (*no imitated target action*) to 4 (*all target actions imitated*). Children did get a score of 1 for clapping if they clapped their hands at least once. The lever pushing action was scored 1, when children pushed the lever at least in 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 scored 1, children had to tap the rod in the palm of their hand at least once or they had to count loudly from one to three. Button pushing was scored 1 only when children used the rod, not their fingers. This method of coding ensured that all of the actions were weighted equally in the NFA score.

Children's behavior was coded by one of the experimenters based on edited video recordings showing only the child acting on the container in the absence of the experimenters (so the condition was not discernible). An additional independent coder who was blind to condition, phase, and hypotheses also coded each video. High interrater reliability ($r_{\text{intraclass}} = .99$) confirmed a very good level of agreement.

Results

As previously stated, children in Experiment 1 first saw a demonstration of the inefficient strategy performed by a communicative experimenter, followed by a demonstration of the efficient strategy performed by a noncommunicative experimenter. All children in the transparent tube condition managed to remove a token from the container during Phase 1 of the experiment. Thus, children's behavior was not affected by the experience of failure. The number of children showing each of the four nonfunctional actions in each condition as well as the frequencies of NFA scores is presented in Table 3.

As descriptive analyses gave reason to check the equal distribution of the number of performed actions involving physical contact with the testing container and actions not involving this kind of mechanical contact, we executed two post hoc Fisher's exact tests. These tests revealed that the children performed significantly more actions involving physical contact with the container (Test Trial 1: $p < .0001$, Test Trial 2: $p < .0001$, two-tailed).

Preliminary analyses revealed that children's sex had no significant impact on imitation rates, so this variable was not included in further analyses. We conducted three statistical tests (one analysis of variance [ANOVA] and two t tests). Level of significance for these tests was thus adjusted according to Bonferroni ($p = .017$).

In a first step, NFA scores of the transparent tube condition were compared with the baseline condition (see Table 3 and Figure 2 for means and standard errors). For this purpose, two independent samples t tests were conducted. In Test Trial 1 as well as in Test Trial 2, the mean NFA scores were significantly higher than in the baseline condition, Test Trial 1: $t(42) = -4.98$, $p = .000$, $d = 1.56$; Test Trial 2: $t(40.52) = -3.71$, $p = .001$, $d = 0.96$. Although overimitation was slightly reduced from Test Trial 1 ($M = 1.96$, $SE = .21$) to Test Trial 2 ($M = 1.43$, $SE = .21$), the NFA score was still significantly above baseline level ($M = 0.50$, $SE = 0.13$). Children observing the inefficient solution (including nonfunctional actions) achieved significantly higher NFA scores than children in the baseline condition, even though the apparatus was fully

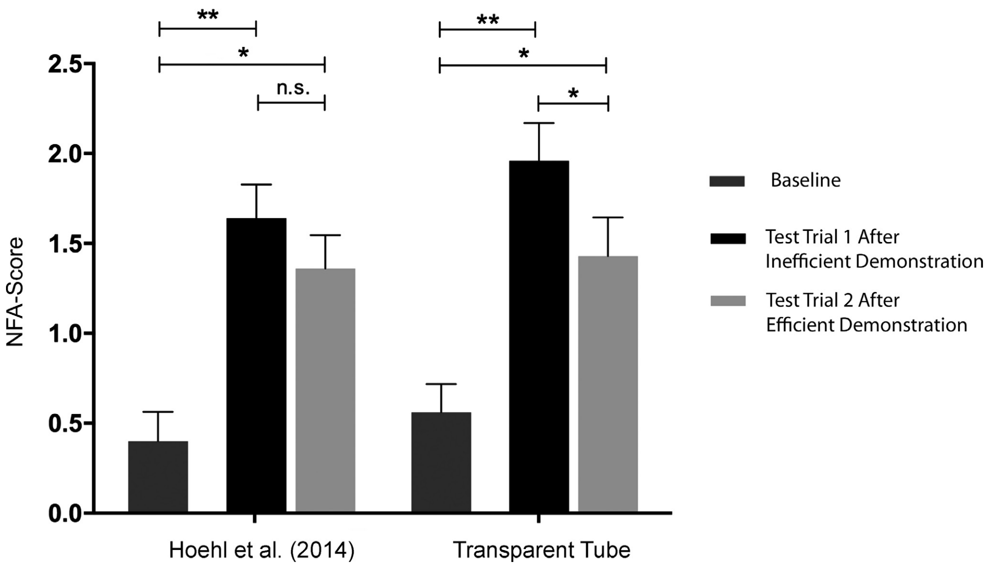

Figure 2. Mean nonfunctional action scores (NFA scores) of Experiment 1 compared to data from Hoehl et al. (2014).
Note. Error bars indicate standard errors. Asterisks indicate significant differences in mean NFA scores. $^{**}p < .001$. $^{*}p < .017$ (p values are Bonferroni corrected).

transparent and they saw that these actions did not affect the tokens (Test Trial 1). After having observed the efficient solution performed by a noncommunicative model during Phase 2, children continued to perform nonfunctional actions above baseline frequency in Test Trial 2.

In a second step, we directly compared data from Hoehl et al. (2014) with the current experiment. These two experiments only differed in the transparency of the tube containing the reward. Therefore, we conducted a repeated measures ANOVA with both experimental conditions with the between-participants factor transparency (transparent, opaque) and the within-participants factor test trial (1 or 2). This analysis revealed a significant main effect for the factor test trial, $F(1, 54) = 11.95$, $p = .001$, $\eta^2 = .18$. Neither the interaction between test trial and transparency, $F(1, 54) = 1.11$, $p = .29$, $\eta^2 = .02$, nor the main effect of transparency, $F(1, 54) = 0.59$, $p = .45$, $\eta^2 = .01$, was significant. Thus, children's overimitative behavior was not influenced by the visibility of the reward.

Discussion

In Experiment 1, 5-year-olds first observed an inefficient method for retrieving tokens from a container, involving several nonfunctional actions. In a second phase, children observed the efficient method to retrieve tokens presented by another experimenter. In contrast to Hoehl et al. (2014), the tube containing the tokens was transparent, so children saw that nonfunctional actions did not causally affect the tokens. After the first demonstration, children imitated nonfunctional actions just as they did when the reward location was opaque. After the following demonstration of the efficient strategy, the rate of overimitation decreased slightly, but it was still above baseline level, that is, children still overimitated.

Theories focusing on children's causal reasoning (Lyons et al., 2007, 2011; Whiten et al., 2009) would have predicted that children overimitate less when they can see that the reward is unaffected by nonfunctional actions (Phase 1) and stop overimitating when they know that these actions are not necessary, that is, after having observed the efficient strategy (Phase 2). These predictions do not fit with our findings. Social theories would have predicted that children overimitate even when they can see that the tokens are unaffected by nonfunctional actions (Phase 1), and they should continue to do so despite having seen the efficient strategy performed by a noncommunicative model (Phase 2). These predictions are more consistent with the results of Experiment 1.

Gergely, Bekkering, and Király (2002) have shown that even 14-month-olds are more likely to faithfully imitate an unusual action (such as tapping a touch-sensitive light with the head rather than the hands) if they do not see any rational reason for this action than if they are provided with a corresponding reason (i.e., hands are occupied).

Older children as in our experiment may encode the experimenter's demonstration of the inefficient strategy as a demonstration of a social norm rather than the optimal strategy to attain the reward. Consistent with this interpretation, we found that children kept on performing inefficient actions above baseline level even after watching a noncommunicative second experimenter who demonstrated a more efficient way to retrieve the reward.

But there are some results that challenge this interpretation and provide indirect evidence for the relevance of causal knowledge. Causal and social explanatory models further differ regarding predictions on which of the irrelevant actions are copied. Only two of the four demonstrated irrelevant actions included physical contact with the reward-containing apparatus. Causal reasoning theories would predict that children copy mainly actions not violating the contact principle, that is, the rule that mechanical interactions cannot occur at a distance (Lyons et al., 2007). Social accounts, in contrast, would predict that all actions are copied with equal frequency. However, in the present study, the actions copied most frequently were those including contact with the testing container (see also Hoehl et al., 2014; Lyons et al., 2007). This finding does not fit with a purely social explanatory model.

In sum, the results of Experiment 1 fit better with social accounts, but there is still no clear picture of the motivations underlying the phenomenon. To further deepen our understanding of the influence of causal and functional factors on overimitation, Experiment 2 was conducted. In this experiment, we enhanced children's knowledge about the irrelevancy of demonstrated actions by changing the demonstration sequence. In addition to the transparent reward location, children now observe the efficient strategy first, before observing the inefficient method in a second phase. This procedure clarifies from the very beginning that the reward can be retrieved with only one functional action, thus providing evidence that all other actions must be nonfunctional.

Experiment 2: How Does Prior Functional Experience Affect Overimitation?

Although causal understanding refers to children's knowledge about the specific mechanism explaining how the reward can be reached and pulled out of the tube, functional understanding refers to children's experiences regarding which actions are required to succeed in getting the reward. In the literature, we find several studies that explicitly manipulate either demonstrating or experiencing the functionality of different actions: Pinkham and Jaswal (2011) found that 18-month-old infants did not adopt inefficient actions when they had the chance to discover a more efficient strategy on their own beforehand. Similar results were reported for older children by Wood, Kendal, and Flynn (2013): Five-year-olds who had personal experience with the test material prior to the demonstration of nonfunctional actions showed less overimitation than children without corresponding experience. These findings suggest that children do not overimitate blindly but rather seem to consider personally acquired knowledge regarding the efficiency of different strategies. Hence, they speak against purely social explanations of the phenomenon. However, Nielsen, Moore, and Mohamedally (2012) report that 4-year-old children imitate nonfunctional actions even when they have the chance to play with the test material beforehand. These conflicting findings may be due to the fact that Nielsen et al. (2012) did not differentiate between self-experience and social observation in their analysis, even though some children opened the test apparatus efficiently by themselves, and other children only saw it being opened efficiently by their parents, which may have had less of an impact on children's later performance.

Further research supports the idea that prior experience through observation has less impact on children's imitation than prior experience through action. Nielsen and Blank (2011) found that children imitate nonfunctional actions even after having observed a more efficient way to reach a reward (see also Hoehl et al., 2014). In these studies, the inefficient strategy was always demonstrated first and highlighted by the presence of the inefficient model during testing phase (Nielsen & Blank, 2011) or through communication (Hoehl et al., 2014). In sum, this pattern of results suggests that information about efficiency acquired through observation can be surpassed by the presence of an inefficient experimenter (i.e., through inducing slight social pressure) or by a communicative demonstration of an inefficient strategy. Both of these findings are more in line with social accounts than causal accounts of overimitation.

As demonstrated so far, existing evidence is still inconclusive: Studies manipulating children's own experience speak against purely social accounts by highlighting the impact of children's functional insight. In contrast, studies manipulating the efficient actions' experience only through observation seem to support social accounts by demonstrating that children may overimitate even after having seen the efficient strategy.

In Experiment 2, we demonstrate the efficient strategy and let the children interact with the testing container to try out this strategy on their own. Hence, social observation and self-experience regarding actions necessary to get the reward are combined. Subsequently, another experimenter presents the inefficient strategy before it is the child's turn again. Whether the efficient demonstrator is communicative or not varies between experimental conditions. In Experiment 2a, both strategies are demonstrated by a communicative experimenter. In Experiment 2b, only the inefficient strategy is presented by a communicative experimenter.

Causal accounts (Lyons et al., 2007, 2011; Whiten et al., 2009) would predict that children do not imitate nonfunctional actions when they are aware of a more efficient strategy (i.e., neither in Experiment 2a nor in Experiment 2b). In contrast, social accounts (Gergely & Csibra, 2006; Kenward, 2012; Nielsen & Blank, 2011) would predict that children may also switch from an efficient to an inefficient strategy if the latter is demonstrated by a socially engaging partner (Experiments 2a and 2b), especially if the efficient strategy is presented noncommunicatively (Experiment 2b).

Experiment 2a: Do Children Overimitate After Having Observed An Efficient Strategy First?

Method

Participants

The experiment was again conducted in a medium-sized German town with participants recruited from a middle-class socioeconomic background. Twenty-eight children (14 males; M = 62.45 months, SD = 1.78) participated. Data were collected between May 2014 and November 2014. Recruitment was done in the same way as in Experiment 1. Two further children were excluded from the final sample because of experimenter error (n = 1) and interference of the parents (n = 1).

Materials and Procedure

Children in this experiment were presented with the same material as in Experiment 1. The procedure was also similar to Experiment 1. Children observed two different experimenters both acting communicatively. As a reference group, the baseline condition of Experiment 1 was used. Experimental conditions of Experiments 2a and 2b are summarized in Table 2. Before entering the testing room, both experimenters welcomed the child. Parents stayed in a separate room. Sex of children and experimenters was balanced. As in Experiment 1, both experimenters were of opposite sex. Each session was video recorded. This time, the child played the warm-up game (i.e., blowing a cotton ball into a goal) with both experimenters at the same time. As in Experiment 1, the child always won tokens, which could be exchanged for stickers. The game was played twice.

Next, the children were introduced to the transparent container. Experimenter A said, "Now we are going to play another game. This game is about this special container." Experimenter B then completed, "There are some more golden marbles in this container. If you can get a marble out, you can exchange it for stickers." After introducing the container, Experimenter B said that he or she had to write something down and sat down at a nearby desk facing away from the scene. Then, Experimenter A started the game ("Okay. Let's start. It's my turn first.") and focused the child's attention by saying "Watch!" or "Look!" Experimenter A retrieved a token by using only the functional action: lifting the flap covering the opening to the tube and removing a marble by using the magnetic rod (Figure 1E). Following that, Experimenter A told the child that he or she could retrieve a token any way he or she liked and then left the room together with Experimenter B (Test Trial 1). As soon as the child was successful (all children were able to get a token), both experimenters returned and Experimenter A helped to exchange the token for stickers. Following that, Experimenter A pretended to write something down and sat down at the desk. Then Experimenter B said, "Now it is my turn," and retrieved a token by using nonfunctional (Figures 1A to 1D) actions as well as the functional action (Figure 1E). After that, the child was instructed to remove a token however he or she liked. Again, both experimenters left the room (Test Trial 2). As soon as the child had retrieved a token, both experimenters reentered and Experimenter B helped the child to exchange the token for stickers.

Results

Coding followed the same rules as in Experiment 1. High interrater reliability ($r_{\text{intraclass}}$ = .98) confirmed a very good level of agreement. Because we conducted a total of seven statistical tests (one ANOVA, six t tests) using the same sample (Experiments 2a and 2b combined), level of significance for

Table 2
Experimental Conditions—Experiment 2

	Phase 1: Efficient demonstration		Phase 2: Inefficient demonstration	
Experiment 2a	Communicative	Test Trial 1	Communicative	Test Trial 2
Experiment 2b	Noncommunicative	Test Trial 1	Communicative	Test Trial 2

all tests was adjusted according to Bonferroni ($p < .007$).

All children in Experiment 2a extracted a token from the container following the first demonstration. Thus, experience of failure did not influence their behavior. The number of children showing each of the four nonfunctional actions and the frequencies of NFA scores in each condition is presented in Table 3. As in Experiment 1, post hoc tests were performed to test the equal distribution of actions involving contact with the container and actions not involving contact with the container. For Test Trial 1, Fisher's exact tests revealed no significant differences in the frequency of actions involving contact with the container or not ($p = 1$, two-tailed). In Test Trial 2, however, significantly more contact actions were performed (Fisher's exact, $p = .006$, two-tailed).

First, we compared the NFA scores of the both test trials of Experiment 2a with the baseline condition (see Table 3 and Figure 3 for means and standard errors), using two independent samples t tests. In Test Trial 1 of Experiment 2a, the mean NFA score was significantly lower than that in the baseline condition, $t(17.33) = 3.47$, $p = .003$, $d = 1.33$. Children performed less irrelevant actions when they observed the efficient strategy than children in the baseline condition. It should be noted that 7 of the 16 children in the baseline condition pushed the lever without having observed somebody doing so before. This reveals that the lever seems to be attractive to the children, so that they exploratively operate it. In Test Trial 1 of Experiment 2a, only one child performed one irrelevant action (pushing the lever). It seems that a demonstration of the efficient strategy decreased explorative behavior. The majority of children did not only observe but also performed the efficient strategy successfully before they saw the inefficient way to retrieve a reward. Results of Test Trial 2 provide information about whether children switched to an inefficient strategy following a social demonstration of irrelevant actions. The NFA score in Test Trial 2 did not differ significantly from baseline level, $t(42) = 1.12$, $p = .27$, $d = 0.34$. Five children performed at least one irrelevant action.

Experiment 2b: Do Children Overimitate Following a Noncommunicative Demonstration of the Efficient Strategy?

In Experiment 2a, children did not switch from an efficient to an inefficient strategy, which is consistent with causal explanatory models of overimitation (Lyons et al., 2007, 2011; Whiten et al., 2009). Hoehl et al. (2014) showed that the models' communicative behavior can affect whether children stick with the first strategy they observe or switch to an alternative strategy demonstrated by a second model. To explore whether communication plays a role in this experimental setting, Experiment 2b was conducted. The key question was whether a communicative inefficient demonstration can elicit overimitation even though children already acquired causal and functional knowledge through observation of a different noncommunicative model demonstrating the efficient strategy.

Regarding the influence of communication on imitative behavior, the *theory of natural pedagogy* (Gergely & Csibra, 2006) seems of interest. This theory assumes that ostensive signals such as eye contact, calling the learner's name, and speaking in a child-directed manner supposedly prepares the learner to be taught relevant information that can be generalized. As demonstrated by Hoehl et al. (2014), ostensive signals can play an important role for switching from an inefficient to an efficient strategy. Five-year-olds imitated nonfunctional actions irrespective of the demonstrators' communicative behavior, but they reduced overimitation more when being subsequently shown the more efficient way to achieve the goal by a communicative experimenter than by a noncommunicative experimenter.

The natural pedagogy account (Gergely & Csibra, 2006) and other social accounts (Kenward, 2012; Nielsen & Blank, 2011) predict that children switch to overimitation in Test Trial 2 when the inefficient strategy (but not the efficient strategy) is demonstrated in a communicative, socially engaging context. In contrast, theories underscoring the role of causal reasoning (Lyons et al., 2007, 2011; Whiten et al., 2009) predict that children will not switch to an inefficient strategy in Test Trial 2 when they already know the efficient way to retrieve a

Table 3
Descriptive Information on the Number of Children Who Performed Each of the Four Nonfunctional Actions in Each Experimental Condition

	Frequency of each nonfunctional action performed				Frequencies of NFA scores					
Condition	Clapping	Pushing lever	Tapping rod	Pushing button	0	1	2	3	4	Mean NFA score (*SE*)
Baseline (*N* = 16)	0	7	0	1	8	8	0	0	0	0.50 (0.13)
Experiment 1—transparent tube (*N* = 28)										
Phase 1 (inefficient demonstration)	3	19	11	22	5	2	10	11	0	1.96 (0.21)**
Phase 2 (efficient demonstration)	1	16	7	16	9	3	11	5	0	1.43 (0.21)*
Experiment 2a—efficient demonstration communicative (*N* = 28)										
Phase 1 (efficient demonstration)	0	1	0	0	27	1	0	0	0	0.04 (0.04)*
Phase 2 (inefficient demonstration)	0	4	0	4	23	2	3	0	0	0.29 (0.12)
Experiment 2b—efficient demonstration noncommunicative (*N* = 28)										
Phase 1 (efficient demonstration)	0	1	0	0	27	1	0	0	0	0.04 (0.04)*
Phase 2 (inefficient demonstration)	0	8	0	11	17	3	8	0	0	0.68 (0.17)

Note Asterisks indicate nonfunctional action scores (NFA scores) that are significantly greater than those in the baseline condition. *p < .017 (Experiment 1). *p < .007 (Experiments 2a and 2b). **p < .001 (critical p values are Bonferroni corrected).

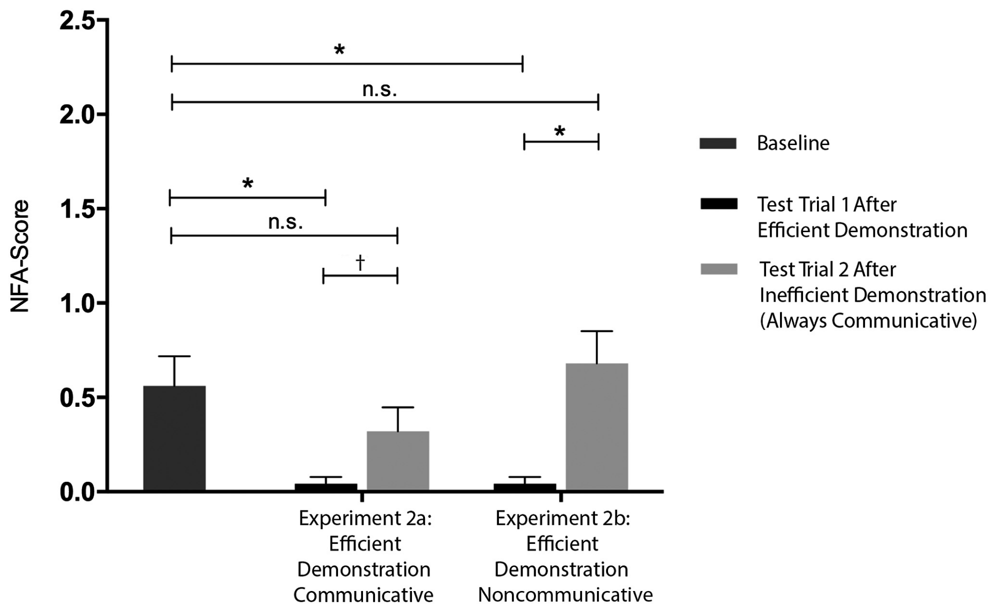

Figure 3. Mean nonfunctional action scores (NFA scores) of Experiments 2a and 2b.
Note. Error bars indicate standard errors. Asterisks indicate significant differences in mean NFA scores. †p < .05. *p < .007 (critical p values was adjusted to .007, Bonferroni corrected).

token. Experiment 2b will clarify which prediction better fits the empirical data.

Method

Participants

The experiment was conducted in the same town as the other experiments. Twenty-eight children (14 males; M = 62.94 months, SD = 1.85) participated. Data were collected between November 2014 and March 2015. Recruitment was identical to the experiments described above. Two further children were excluded from the final sample because of experimenter error (n = 1) and interference of the parents (n = 1).

Materials and Procedure

Warm-up game was identical to Experiment 1, with only one experimenter. The imitation task was similar as in Experiment 2a with one variation: Only Experimenter A interacted with the child (i.e., during the warm-up phase and thereafter). The efficient strategy was now demonstrated in a noncommunicative context by Experimenter B during the first phase, followed by the demonstration of the inefficient strategy during the second phase.

Experimenter A introduced the children to the apparatus, but then explained that he or she had to write something down and sat down at a nearby table facing away from the child. Next, Experimenter B entered the room and expressed his or her intention to get a sticker. Once Experimenter B got himself or herself a token by performing the efficient action only, he or she left the room. Experimenter A returned to the child and told him or her to retrieve a token however he or she liked. During the test phase, Experimenter A also left the room. Once the child had succeeded in retrieving a token, Experimenter A returned and helped him or her to exchange the token for a sticker. Then the second demonstration began and Experimenter A said, "Now we can start playing. It's my turn first." After insuring that the children were attentive, he or she demonstrated the inefficient strategy (Figures 1A to 1E) as described previously. In the next step, the child was instructed to retrieve a marble any way he or she liked and Experimenter A left the room again until the child succeeded. Then he or she helped the child to exchange the token for stickers.

Results

The same coding as in Experiments 1 and 2a was used. An interrater reliability of $r_{\text{intraclass}} = 1$ confirmed a perfect level of agreement.

As in the previous experiment, all children retrieved a token in Test Trial 1. As in Experiments 1 and 2a, post hoc tests were performed to tests for equal distribution of contact versus no contact actions. As in Experiment 2a, no significant differences in the frequency of actions involving contact with the container or no contact could be found in Test Trial 1 ($p = 1$, two-tailed). In Test Trial 2, however, significantly more contact actions were performed (Fisher's exact, $p < .0001$, two-tailed).

For further analyses level of significance was Bonferroni adjusted as explained in Experiment 2a ($p < .007$). Imitation scores for both test trials were compared with the baseline condition (i.e., data from Experiment 1) using two independent samples t test. Results revealed nearly the same pattern as in Experiment 2a. In Test Trial 1 of Experiment 2b, the mean NFA score was significantly lower than that in the baseline condition, $t(17.33) = 3.47$, $p = .003$, $d = 1.33$. The NFA score in Test Trial 2 was at baseline level, $t(41.99) = -0.83$, $p = .41$, $d = 0.23$. Thus, children did not switch to the communicatively demonstrated inefficient strategy.

Integrated Analysis (Experiments 2a and 2b Combined)

We included Experiments 2a and 2b in one overall analysis to directly compare performance across conditions. A repeated measures ANOVA with the between-participants factor communicativeness of the efficient demonstration (communicative, noncommunicative) and the within-participants factor test trial (1 or 2) revealed a significant main effect for test trial, $F(1, 54) = 20.31$, $p < .0001$, $\eta^2 = .27$, indicating more nonfunctional actions in Test Trial 2 compared to Test Trial 1. The interaction between test trial and the factor communicativeness of the efficient demonstration was marginally significant, $F(1, 54) = 3.93$, $p = .052$, $\eta^2 = .07$. To further explore the nature of this marginal interaction, we examined whether children's NFA score changed between Test Trial 1 and Test Trial 2 in Experiments 2a and 2b, respectively, using dependent samples t tests. For Experiment 2a, we found a marginal but nonsignificant difference in children's NFA score between Test Trial 1 and Test Trial 2, $t(27) = -2.26$, $p = .032$, $d = 0.52$ (critical p values were adjusted to .007, Bonferroni corrected). Only five of the 28 children performed at least one nonfunctional action in Test Trial 2. In Experiment 2b, we found a significant difference of children's NFA score between Test Trial 1 and Test Trial 2, $t(27) = -3.91$, $p = .001$, $d = 0.98$. Eleven of 28 children performed at least one nonfunctional action in Test Trial 2.

Discussion of Experiments 2a and 2b

In Experiments 2a and 2b, 5-year-olds first saw an efficient method to retrieve tokens from a container. Afterward the children could extract a reward on their own, thus acquiring functional experience with the efficient strategy. In a second phase, a different experimenter showed them an inefficient strategy, including nonfunctional actions. Following that, the children were again encouraged to retrieve a token on their own. In Experiment 2a, both experimenters acted equally communicatively with the child. In Experiment 2b, only Experimenter B, who demonstrated the inefficient method, was communicative. Following the demonstration, children were again encouraged to retrieve a token on their own.

Accounts focusing on causal reasoning and the role of functional knowledge would predict that children should stick with the efficient strategy. Assuming that communicativeness emphasizes the social relevance of the demonstration, the natural pedagogy account would expect children to switch to the inefficient strategy, especially when it is the only strategy presented in a communicative context (Experiment 2b). However, in Experiment 2a, as well as in Experiment 2b, children's performance of nonfunctional actions did not rise above baseline level following the demonstration of the inefficient strategy. Therefore, these findings seem to support theories highlighting the role of causal and functional knowledge. It should be noted that only five of the 28 children participating in Experiment 2a showed at least one nonfunctional action in Test Trial 2, whereas in Experiment 2b, 11 of the 28 children showed a corresponding response. Although the mean NFA score still did not exceed the baseline level, children showed significantly more nonfunctional actions in Test Trial 2 than in Test Trial 1. Why do some children adopt an inefficient method when they already know an easier and faster way to retrieve a reward? The communicative context seems to affect children's imitation behavior. Because the inefficient model was communicative in both conditions, we conclude that the first and efficient model had a slightly reduced impact on children's behavior when he or she was noncommunicative. Children who adopted the inefficient strategy may have felt a greater need to affiliate with the communicative experimenter than the other children in Experiment 2b, whereas children with a high need for affiliation may have experienced a conflict in Experiment 2a, resulting in some of them adopting the inefficient strategy ($n = 5$) and some of them sticking with the first and efficient strategy. In Experiment 2b, only the children and the inefficient experimenter communicated with each other, whereas the efficient experimenter was not part of this interaction. Therefore, children may have interpreted the communicative experimenter's behavior as an introduction of new rules relevant only for this minimal group. Furthermore, personality variables or temperament characteristics such as extraversion or novelty seeking may influence children's imitation behavior. By focusing on group processes and also individual differences, future research could shed some more light on children's motivation to switch to a more inefficient strategy.

We expected that social motivation would lead to an equal distribution of all kinds of demonstrated actions (actions with and without contact with the container). Intriguingly however, this is not what we observed. None of the children in Experiments 2a and 2b completed the two actions least likely to have a causal effect (clapping and tapping the rod). Because children knew about the irrelevancy of these actions, causal reasoning alone does not serve as a convincing explanation for this finding. What could be the reason for children copying only contact actions if they do it for social reasons? On the one hand, it is possible that children have internalized the contact principle to such an extent that it determines their actions—even though the goal of these actions is not a causal effect but rather a social bond between child and experimenter. In this view, social goals and learning goals should not be seen as one or the other alternatives but might be integrated by the children. Consequently, some children adopt nonfunctional actions in order to affiliate but only those that could potentially have an effect at all. It is also possible that through the execution of the efficient action children's attention is focused on the box, which leads to more precise encoding of the contact actions during demonstration. Since 7 of the 16 children in the baseline condition operated the lever on the top of the box, it might also be that the features of the apparatus used for the irrelevant actions were really attractive to the children, thus bearing a greater affordance than the no contact actions.

General Discussion

In two experiments, we manipulated children's knowledge about the causal mechanism and the functionality of demonstrated actions. In Experiment 1 we increased the transparency of the container (more precisely the tube containing the reward) to ensure that children could see that the reward remained unaffected by demonstrated nonfunctional actions. As revealed by a comparison between previous findings (Hoehl et al., 2014) and Experiment 1, causal transparency did not affect children's overimitative behavior. Participants performed nonfunctional actions although they could clearly see the reward and they continued doing so even after watching a noncommunicative model demonstrating the efficient strategy. These results contradict causal explanatory models stating that children should stop overimitating as soon as they know which actions are irrelevant (Lyons et al., 2007, 2011). Rather, Experiment 1 seems to support social accounts suggesting that 5-year-olds are likely to imitate nonfunctional actions presented by a social-communicative experimenter and keep on doing so even after having observed the efficient strategy to reach the goal. By replicating previous findings of Hoehl et al. (2014) with an independent sample and in a condition with increased causal transparency, our data confirm the relevance of social factors for explaining the phenomenon of overimitation.

However, results of Experiments 2a and 2b point to a different conclusion. In these experiments, we demonstrated the efficient strategy first, thus increasing children's functional knowledge about the demonstrated actions. In both conditions all children except one each used the efficient strategy following a corresponding demonstration and their imitation rate following the subsequent inefficient demonstration did not exceed the rate observed in the baseline group. These results point to the relevance of accounts highlighting the role of causal and functional knowledge, stating that children do not overimitate when they have already understood the causal mechanism and have already experienced the demonstrated actions to be nonfunctional. Social theories would have predicted an increase in overimitation due to the enhanced obviousness of the nonfunctionality of ineffective actions, which was not found. Furthermore, children predominantly imitated actions performed on the container underscoring the role of causal and functional plausibility for explaining children's overimitation.

How can this apparent contradiction be explained? Over and Carpenter (2012) suggested that children's tendency to copy observed actions depends on their goals in the specific experimental situation. These goals could either be learning goals (i.e., how to retrieve the token most efficiently), social goals (i.e., how to establish a good relationship with the experimenter), or a combination of both. Although some experimental situations create a context focusing the children on "how to reach a goal," thus emphasizing social factors, others may highlight the goal itself, thus highlighting the relevance of causal and functional information. In the study by Nielsen and Blank (2011), 4- to 5-year-old children imitated nonfunctional actions only if the adult who demonstrated these irrelevant actions was present to witness their behavior. The experimenter's presence in the room may have exerted social pressure on the children to imitate his or her actions, thus highlighting social goals. In the study by Wood et al. (2013), children did not overimitate when they had personally found a more efficient strategy beforehand. Children may have focused on the reward and how to receive it most efficiently, triggering a strong learning goal. Consequently, no overimitation occurred.

The account by Over and Carpenter (2012) fits well with our current findings. In the present study, when children observed and carried out the efficient strategy in a fully transparent condition before they observed a communicative demonstration of the inefficient method, only a few children switched to the inefficient solution. Seeing the efficient strategy first may lead children to focus on the functional value of the demonstrated action instead, thus reducing the social goal and enhancing a learning goal. As a consequence, children show less overimitation following the second demonstration even if this demonstration is performed by a communicative experimenter (Experiment 2). This also fits with the finding that children interpret behavior instrumentally if the underlying physical causality is potentially knowable (e.g., Kapitány & Nielsen, 2015; Legare et al., 2015; Wilks et al., 2016).

However, some children in Experiments 2a and 2b adopted the inefficient strategy anyway following the demonstration of a communicative experimenter. Maybe these children have a greater need for social recognition and are more likely to prioritize social goals rather than learning goals in general.

In contrast, when the inefficient strategy was demonstrated first, the majority of children faithfully imitated the nonfunctional actions even after observing the efficient action in a second trial. Causal transparency of the testing object could make it very obvious to children that there is no functional reason to perform these actions. When seeing the inefficient strategy first, including clearly nonfunctional actions, they might figure that these actions do not have a causal but rather a social purpose, namely to teach the child a social norm. This could enhance the relevance of social goals (in addition to a potentially weaker learning goal to retrieve the reward), thus leading to overimitation following the first demonstration of the inefficient strategy. If goal choice remains stable, children still overimitate after seeing the noncommunicative demonstration of the efficient strategy in the second phase. This is consistent with recent findings revealing that children interpret actions as social or conventional if they are unable to understand physical causal processes underlying the demonstrated actions (e.g., Kapitány & Nielsen, 2015; Legare et al., 2015; Wilks et al., 2016). In the present case, children can see the causal mechanism, but this may make them wonder why the experimenter demonstrates nonfunctional actions. Thus, the order of demonstrated action strategies matters.

However, it should be noted that children do not always simply stick with the first strategy they have observed. In a previous study, with a very similar task by Hoehl et al. (2014), children did switch from an inefficient strategy to the efficient action when the latter was presented communicatively. Nonetheless, the sequence of both types of demonstration may affect how children evaluate the specific situation.

The current study suggests that both social motives and causal understanding should be taken into account for explaining overimitation in 5-year-olds. As demonstrated, children's social motivation to comply with a communicative experimenter, as well as the task's causal transparency (e.g., transparent reward location) and the children's functional experience (e.g., demonstrating the efficient strategy first), had an impact on their choice to either imitate nonfunctional actions or to copy observed actions selectively. The sequence in which efficient and inefficient strategies are introduced may be critical to determine whether children prioritize social goals (i.e., to affiliate with the experimenter, thus showing overimitation) or learning goals (i.e., to get the reward in the most efficient way).

This finding has important implications for the design of studies exploring the phenomenon of overimitation, and it raises interesting questions for future research. It is important to mention that in this study design children who observed the efficient strategy first did not just see that strategy, but most of them (except two children) experienced it themselves by applying the efficient strategy before they saw the inefficient demonstration. It should be investigated further if only observing the efficient before the inefficient strategy leads to a similar effect. Moreover, it seems crucial to investigate the role of social factors other than communication on overimitation. Would children switch from an efficient to an inefficient strategy if social pressure was enhanced by the presence of the inefficient model during testing phase? How do other social factors such as group membership affect the imitation of nonfunctional actions? Furthermore, future research may focus on individual differences such as personality characteristics that may explain differences in children's imitative behavior.

The tendency for humans to overimitate seems to be extremely powerful. However, the tendency to copy irrelevant actions blindly can be overcome when children learn and carry out a more efficient strategy beforehand.

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III. MANUSCRIPT

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Who's on my team? Minimal group and

gender influences on over-imitation

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Abstract

This study investigates influences of group membership on overimitation, focusing on an artificially formed minimal group and the pre-existing group gender. Influences of these groups on (i) eliciting overimitation after an inefficient demonstration and on (ii) maintaining overimitation after an efficient demonstration are studied. In three conditions, 5-to-6-year-old preschoolers (N = 28 per condition) observed a model belonging to an artificial in-group using an inefficient strategy including irrelevant actions to retrieve a reward (Phase 1) and subsequently an out-group model using only the relevant action. These three conditions varied in the emphasis of artificial group membership. In a fourth condition, the inefficient strategy was presented by an out-group model (Phase 1) and the efficient strategy by an in-group model. Sex of the models was counterbalanced in order to also investigate gender-group influences. Results revealed that even though children's overimitation was influenced by the group formation process, artificial group membership itself did not affect their tendency to overimitate. Whether the children observed either strategy by an artificial in-group or out-group model did not make a difference. However, gender groups had an effect on children's overimitation. Children overimitated more if the irrelevant actions were demonstrated by a female model. This effect was mainly driven by girls not overimitating male models, whereas boys overimitate male and female models equally.

Keywords: overimitation, preschoolers, group membership, gender, social cognition

Who's on my team? Minimal group and gender influences on overimitation

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Imitation is a powerful learning strategy. Children quickly acquire novel actions by observing and copying others. Their propensity to imitate is so strong that they even reproduce actions with no apparent causal function. This phenomenon is referred to as "overimitation" (McGuigan & Whiten, 2009; Nielsen & Tomaselli, 2010). It emerges in children from the age of three onwards and seems to consolidate in the transition to adulthood (Flynn & Smith, 2012; McGuigan, Makinson, & Whiten, 2011). High-fidelity imitation, which results in overimitation as soon as irrelevant actions are included, is proposed to serve a crucial function in the transmission of human culture (Nielsen & Tomaselli, 2010). It seems to be an adaptive strategy enabling much faster social learning of instrumental skills than would be possible if copying required a full causal understanding of an event. Furthermore, overimitation enables social learning of conventional knowledge and rituals (Legare, 2017). The transmission of rituals and norms is higher within groups than between groups (Zucker, 1977). If overimitation is one of the driving mechanisms in the transmission of cultural knowledge, including social norms and rituals (Kenward, 2012; Keupp, Behne, & Rakoczy, 2013; Legare, 2017), it should be sensitive to group membership. Testing this hypothesis is the purpose of this study.

How does group membership affect whose actions we copy? The tendency to copy faithfully and the meaning of group membership for children develop in parallel. Both increase significantly between three and five years of age (McGuigan, Whiten, Flynn, & Horner, 2007; Richter, Over, & Dunham, 2016). One strategy to become an accepted member of a group is to behave in similar ways like other group members. Similarity in behavior fosters group membership, facilitates group cohesion, and serves the within-group transmission of culturally relevant knowledge, resulting in a decrease of intra-group differences and an increase of inter-group differences consequently supporting the distinction of in-group from out-group members (e.g. Haun & Tomasello, 2011; Henrich, 2009; Wilks, Collier-Baker, & Nielsen, 2015).

Various preferences for in-group members, so called in-group biases, have been reported in early development. For example, it was shown that children prefer people showing loyal behavior to their group (Misch, Over, & Carpenter, 2014). Children were even willing to pay costs to behave loyally to their group themselves: Children were significantly less likely to reveal a secret of in-group members than one of out-group members, even if offered a reward for doing so (Misch, Over, & Carpenter, 2016). Another study has shown that children are more generous to in-group members than to out-group members (Buttelmann & Böhm, 2014). Many studies manipulated group membership through language, comparing children's behavior towards people speaking their native language vs. people speaking a foreign language. For example, 6-month-old children looked longer at people who talk in their native language and 10-month-olds showed object and information preferences for objects presented by someone speaking their own language (Kinzler, Corriveau, & Harris, 2011; Kinzler, Dupoux, & Spelke, 2007). Another study found that children are more likely to generalize object functions to objects following a demonstration from a linguistic in-group member (Oláh, Elekes, Pető, Peres, & Király, 2016). As counterpart to the in-group bias, humans try to contrast their behavior to that of an out-group, which is called out-group derogation. For instance, it was found that adults change object-preferences to demonstrate distance to out-group (Izuma & Adolphs, 2013) and that children attribute negative characteristics to out-group members (Aboud, 2003; Buttelmann & Böhm, 2014).

Such in-group biases and out-group derogations also influence children's choice of whom they imitate. Three-year-olds (Howard, Henderson, Carrazza, & Woodward, 2015) and even 14-month olds (Buttelmann, Zmyj, Daum, & Carpenter, 2013) are more likely to imitate actions of linguistic in-group members than out-group members. It has been interpreted that they ignore behavior modeled by out-group members presumably because it is less relevant to them (Howard et al., 2015). In addition, it has been reported that children (Oostenbroek & Over, 2015) as well as adults (Ruys, Spears, Gordijn, & Vries, 2007) try to distance themselves from an artificially formed out-group by behaving differently. However, there are also contradicting findings showing that 4-year-olds do not necessarily imitate a racial in-group model more often than an out-group model (Krieger, Möller, Zmyj, & Aschersleben, 2016).

Besides focusing on who we like to imitate, some studies investigate how we perceive people that imitate us. For example, it has been shown that children trust people who imitated them more (Over, Carpenter, Spears, & Gattis, 2013). It seems that we imitate to be liked and to be trusted and that we like and trust those who imitate us. Imitation of actions bearing no causal function, i.e. overimitation, may thus be a prime example of a behavioral strategy to strengthen group cohesion and at the same time to distance oneself from out-group members. Therefore, we hypothesized that children would be particularly prone to imitating non-functional actions from in-group members.

As far we know, one study has investigated influences of group membership on overimitation (Gruber, Deschenaux, Frick, & Clément, 2017). In that study, different colored t-shirts were used to form artificial groups. They found that children show in-group preferences in their imitation of meaningless actions. However, this was only the case if the in-group models created a common link by behaving congruent to the child in a prior task. To expand the investigations of group membership and overimitation we would like to compare influences of different type of groups and how they might change if they are in conflict with children's pursuit for efficiency.

In about ten years of research on overimitation, the phenomenon has typically been investigated using a paradigm where participants first see how a model retrieves a reward from a puzzle box using a combination of nonfunctional (e.g., tapping on the surface of the box) and functional actions (e.g., opening a lid to retrieve a reward). After observing the model, children (McGuigan & Whiten, 2009; Nielsen & Tomaselli, 2009) as well as adults (Flynn & Smith, 2012; McGuigan et al., 2011) tend to copy both functional actions as well as nonfunctional actions. Crucially, nonfunctional actions are not performed when participants operate the container without prior demonstration (e.g., Hoehl, Zettersten, Schleihauf, Grätz, & Pauen, 2014; Lyons, Damrosch, Lin, Macris, & Keil, 2011; Lyons et al., 2007).

By now several explanatory models for overimitation have been discussed. Lyons et al. (Lyons, Damrosch, Lin, Macris, & Keil, 2011) argued that children automatically encode observed actions as causally relevant and, therefore, reproduce them (*automatic causal encoding* hypothesis). 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 et al., 2013; Nielsen & Blank, 2011). Others have combined these theories and suggested that children's tendency to copy observed actions depends on their goals in specific situations (Over & Carpenter, 2012). These goals could either be learning goals (i.e., learning about the function of an apparatus), social goals (i.e., establishing a good relationship with somebody), or a combination of both (i.e. following rules of a game). If children have learning goals, they tend to behave more efficiently; if overimitation occurs anyway they might have encoded observed actions as causally relevant. If children have social goals, they are poised to imitate actions, even when they are not goal-directed. Hence, activating social goals should enhance children's overimitation. Within groups, members are motivated to strengthen the social bond between each other. Therefore, belonging to the same group as the model might activate children's social goals and make them sensitive for culturally relevant knowledge, such as rituals and norms.

In this article we distinguish between two types of groups: (1) enduring "societal groups", such as groups based on gender, language, race, or nationality (Dunham, Baron, & Carey, 2011; Tajfel & Turner, 1986), and (2) temporary "artificial groups", such as teams in a competition with members of the same team wearing identical jerseys. The present study addresses both types of groups. More specifically, we focus on gender and team membership as examples.

Gender is a highly relevant societal group. The idea that gender role development is depended on children's tendencies to imitate same-sex models more than opposite-sex models became central to many theories of sex typing in the 1960s-1980s. This idea was referred to as same-sex imitation (Bussey & Perry, 1982b; Fryrear & Thelen, 1969; Perloff, 1982; e.g. D. G. Perry & Bussey, 1979; Raskin & Israel, 1981). It was found that children attend more to a same-sex model, and that this effect is even increasing as children develop an understanding of gender constancy (Slaby & Frey, 1975), with boys showing a stronger tendency in this direction than girls do: Whereas girls oriented their behavior towards that of female and male models, boys oriented their behavior towards male models (for 3- to 5-year-olds: (Bussey & Bandura, 1984); for 8- to 9-year-olds: (D. G. Perry & Bussey, 1979). Furthermore, it was found, that boys tend to reject opposite-sex behavior more than girls do (Bussey & Perry, 1982a). Later, only little research was devoted to the topic of same-sex imitation, although some studies investigated effects of maternal vs. paternal modeling on children’s expression of fearfulness or pain (Boerner, Chambers, McGrath, LoLordo, & Uher, 2017; Fillingim, Edwards, & Powell, 2000).

In a very recent study gender effects on overimitation were found, whereby boys copied more irrelevant actions than girls (Frick, Clément, & Gruber, 2017). However, only effects of child's sex and not the model's sex were investigated. Another study reported that children rather endorse information coming from gender in-group members (Terrier, Bernard, Mercier, & Clément, 2016). Conversely, in adults, women have been observed to copy more precisely and more rapidly irrelevant tool actions performed by a male model (McGuigan, Gladstone, & Cook, 2012). Since rigidity of gender roles has changed tremendously during the last decades (Lindsey, 2016), new research on gender effects on social learning and social interactions is indispensable. In the current research, we therefore explore whether children's overimitation is affected by the sex of the model, and in particular, the match between the child's and the model's sex. Based on the early work on same-sex imitation, a higher degree of overimitation can be expected when children observe a same-sex model, especially for boys. However, societal changes in favor of more flexible gender roles might mitigate the effect compared to findings from the 1970s.

To understand group dynamics and cultural transmission not only pre-existing cultural and societal groups are studied; a growing body of research also focuses on artificial groups. Purely arbitrary categorical groups created in the laboratory (i.e. for the purpose of the study) are often called "minimal groups". A minimal group is established through mechanisms such as preferences in abstract paintings, supposed performance in estimation tasks (Tajfel, Billig, Bundy, & Flament, 1971) or through drawing a colored token from a box (e.g. Dunham et al., 2011). In the original definition of an ideal minimal group, there is "neither a conflict of interests nor previously existing hostility between the groups. No social interaction takes place between the subjects, nor is there any rational link between economic self-interest and the strategy of in-group favoritism. Thus, these groups are purely cognitive […]" (Tajfel & Turner, 1986). Experiments on minimal groups have reliably shown that such an ad hoc intergroup categorization is sufficient to lead to in-group favoritism and out-group discrimination (e.g. Dunham et al., 2011; Spielman, 2000), already in children from three to four years of age (Richter et al., 2016).

In this study, we explore how sex-group membership and/or different degrees of commitment to an artificial group influence children's tendency to overimitate. Theories suggesting a strong role of social motives for overimitation would predict increased overimitation of in-group members compared to out-group members for both kinds of groups. However, group identification can differ for artificially formed and pre-existing groups and might therefore influence overimitation differently. In particular, a stronger in-group bias might be expected for the pre-existing group of gender.

For artificially formed groups, we manipulated group membership in three conditions, whereby group formation was emphasized gradually. In the first condition, we formed groups by simply asking group members to wear t-shirts of the same color (*Condition 1: minimal group*). In the second condition, we added group labels and the experimenters expressed joy about being in a certain team (*Condition 2: medium group*). In the third and fourth condition, we further announced that both teams were competing (*Condition 3 & 4: maximum group*). To assess the effects of gender-group membership, we used one male and one female model for each child. This allowed us to also explore the effects of gender-group membership, orthogonally to our artificial group manipulation. Since group membership is known to play a special role in the transmission of culturally relevant knowledge, we hypothesize that a high social motivation to belong to a given group should increase the likelihood to imitate inefficient behaviors from in-group members, but decrease the likelihood to imitate the same type of behavior from out-group members. In short, we assume that overimitation rates vary with the degree of commitment to a given group.

To test our hypotheses, we referred to a previously introduced experimental paradigm (Hoehl et al., 2014), presenting one model showing an inefficient strategy to achieve a given goal, including nonfunctional actions to extract a reward from a puzzle box (Phase 1) and the other model demonstrating the most efficient strategy in the same task context, leaving out all unnecessary actions (Phase 2). In this situation, children experience a conflict between their motivation to imitate the model and their motivation to achieve a given goal in the most efficient way. Following each demonstration, the child was left alone to retrieve a reward. Hoehl et al. (2014) found that children overimitated in Phase 1, but switched to the efficient strategy in Phase 2, when both models were communicative and addressed the child directly. In the present case, both models were equally communicative, but one model belonged to the in-group, the other to the out-group.

Artificial group-formation took part prior to the overimitation task and varied between conditions (minimum (*Condition 1*), medium (*Condition 2*), maximum (*Condition 3 & 4*) emphasis on group membership as described above). Gender as a societal group was varied by having one male and one female model in each phase (counterbalancing which model was demonstrating during Phase 1 and 2). Based on the above-reviewed findings, we expected overimitation rates following a demonstration of the inefficient strategy to be higher when the demonstration was provided by an artificial/ gender in-group member compared to an out-group member (Phase 1). Further, we expect that children continue to overimitate after an efficient demonstration (Phase 2) if this is presented by an out-group member. This way children would match their behavior to the in-group and contrast it to the out-group. When the inefficient strategy was performed by an out-group member (Phase 1) and the efficient strategy by an in-group member, we expected that children would contrast their behavior to that of the out-group and consequently rarely overimitate in Phase 1 and match their behavior with the in-group and therefore switch to the efficient strategy in Phase 2.

Method

Conditions

Four experimental conditions were tested. In three of these conditions the inefficient strategy (Phase 1) was demonstrated by an artificial in-group model and the efficient strategy was demonstrated by an out-group model (Phase 2). These conditions only varied with respect to how strongly we emphasized the relevance of artificial group-membership (minimal, medium, maximum). In the fourth condition, the inefficient strategy (Phase 1) was demonstrated by an out-group model and the efficient strategy was demonstrated by an in-group model (Phase 2). This allowed us to compare the impact of in- vs. out-group membership directly for Phase 1, using a between-subject comparison. The group formation process in that condition was the one where group membership was emphasized the most and was found to be most effective in the former conditions (maximum emphasis of group-membership including mentioning a competition between groups).

Participants

The study was conducted in two medium-sized German university towns. One-hundred-and-forty-six 5-year-old preschoolers were included in the analyses (74 females, 72 males; M = 64,98 months, SD = 3.90). We conducted a power analysis to ensure that the probability of correctly rejecting a false null hypothesis was adequate (power = .80). Five-year-olds were tested because overimitation is a robust phenomenon at this age (McGuigan et al., 2007) and both an in-group bias and out-group derogation have been reported for this age group (e.g. Howard et al., 2015; Oostenbroek & Over, 2015). For comparison, we used a baseline condition (n=16) from Schleihauf, Graetz, Pauen and Hoehl (2017), but recruited 12 more children (total: n = 28) to align group sizes across conditions and to allow for parametric data analyses. One-hundred-and-thirty-eight children were recruited from an existing pool of families who previously expressed their interest in participating in developmental research.

Parents first received an invitation letter and were later called by phone to receive more information about the purpose and procedure of the study. Most children came to our lab for testing (accompanied by their parents), but 14 were also tested in a separate room of a daycare center. The majority of participants were Caucasian from middle-class socioeconomic backgrounds. An additional nine children were excluded from the final sample because of experimenter error (n = 4), children's failure to extract a token in Phase 1 (n=2) or unwillingness to participate (n = 2), or participation in a topic-related study in another lab two weeks before testing (n=1). All participants received a small gift and certificate for participation.

Materials

A clear Plexiglas®-box was used. The transparent material revealed the irrelevance of certain actions performed during the modeling phase of the experiment (see Figure 1). A transparent tube was located within the box. This tube contained tokens, i.e. golden marbles with small magnets attached to them. The tokens could be removed by inserting a magnetic rod into the opening of the tube at the front of the box. A black lever was attached to the top of the box and a button, which could be pushed using the rod, was attached on the right side. The lever and the button had no functions and were obviously not connected to the tube containing the marbles. Further, we used two cardboard boxes to exchange the tokens for the stickers. One was golden and had a little hole in it's lit, through which the tokens could be inserted. The other box was heart-shaped and contained the stickers.

For group formation two black plastic boxes were used. One contained blue and red child-sized shirts, the other one contained blue and red grown-up-sized shirts. Both boxes were covered with black fabric. Through a narrow slit in the fabric, which you couldn't see through, the shirts could be drawn out of the boxes. Therefore, it appeared to be coincidental whether the children drew a blue or a red shirt.

Procedure

Children assigned to the baseline condition interacted with one experimenter who never showed them how to operate the box. Children assigned to any of the experimental conditions interacted with two experimenters (one male one female), both serving as models in the study. Before entering the testing room, the experimenter(s) welcomed the child and explained that they were going to play some games together. For children tested in the lab parents were asked to wait in a separate room during the session. For children tested in the daycare center, children were accompanied to the testing room by a kindergarten teacher and told that the teacher was waiting for them to come back. If children refused to stay alone with the experimenters, the parents or kindergarten teachers were asked to sit in the corner of the testing room (out-of-sight of the child) and to avoid communicating with the child (n = 12).

Before the study was conducted a randomization-scheme was generated, which determined if the female or male experimenter acted as the in-group or out-group model (for the artificially formed groups). Gender of children and experimenters was almost equally balanced across all conditions. For approximately half of the children the in-group experimenter was of the same sex, for the other half of the opposite sex. However, for five children (all in *Condition 4*: *maximum group (ineff-out-group))* the assignment of the gender for in-and out-group experimenters went wrong. Therefore, we added four more children in that condition to achieve approximate counterbalancing.

Each session was recorded on video. Experimental conditions are summarized in Table 1.

Warm-up phase. Each condition started with a warm-up phase. Children played a competitive game (i.e., blowing a cotton ball into a goal) with the experimenter(s). This way, 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 only once in the baseline condition, but twice in experimental conditions involving two experimenters, to ensure that the child had some interaction with each adult involved.

Baseline condition. Data for this condition partly originate from Schleihauf et al. (2017). To establish the baseline production of the irrelevant actions, children were prompted to attempt to remove a token without prior instruction or demonstration. The experimenter told the child that he/she could retrieve a token however he/she wanted. Following this instruction, the experimenter left the room and reentered after (a) the child successfully had retrieved one token, (b) the child had stopped interacting with the box for at least 30 s, or (c) 80 s had elapsed.

Artificial Group formation in the experimental conditions. Before the start of the first demonstration phase, children in the four experimental conditions participated in a group-formation process. Group formations were all based on minimal group manipulations as described above. In the following, to distinguish stage of group emphasis, we named out conditions minimal, medium and maximum condition. Please note, that all these conditions are variations of classical minimal group manipulations.

There were two possibilities of in-group vs. out-group membership of the inefficient and efficient experimenters: (a) The inefficient model became an in-group member and the efficient model became an out-group member. That allocation was used with the *Condition 1 (minimal group), Condition 2 (medium group)* and *Condition 3* (*maximum group* (*ineff-in-group)*. (b) The inefficient model became an out-group member and the efficient model became an in-group member. That allocation was only used with *Condition 4 (maximum group (ineff-out-group)* condition.

In *Condition 1: minimal group,* group formation was based on the definition of minimal groups by Dunham et al. (2011), stating that the dimension of classification upon which intergroup categorization rests must be value-neutral. This implies that there should be no between group competition or unequal status between groups, and no opportunity for differential interaction with in-groups or out-groups, which could indirectly lead to preference. To comply with that definition, the child and the experimenters in our studies both drew blue and red colored shirts out of black plastic boxes. No group-labels were used, no information about the groups' importance or status was given, no emotions about group-membership were expressed and no competition between the groups was announced. To ensure equal interaction of both experimenters, the in-group-experimenter announced: "Before we play the next game, each one of us have to draw a t-shirt out of these boxes and put it on. There are red and blue shirts and you cannot swap the drawn color." Then the other experimenter explained: "In this box (pointing at box A) are smaller shirts for children and in this box (pointing at box B) are the bigger shirts for the grown-ups. You can go first." First the child, and then each experimenter drew a shirt. Both experimenters accepted the drawn color neutrally. No further comments regarding group formation were made.

In *Condition 2: medium group,* we applied findings by (Bigler, Jones, & Lobliner, 1997; Bigler, Spears Brown, & Markell, 2001) reporting that in older children intergroup biases were only present when the groups were explicitly labeled. Therefore, we added group labels to the procedure described above. Hence, the in-group-experimenter announced: "Before we play the next game, we are going to form teams. Therefore, all of us have to draw a t-shirt out of these boxes and put them on. If you draw a red shirt, you are a member of team red. If you draw a blue shirt, you are a member of team blue. You cannot swap the drawn color". Then the out-group experimenter said: "In this box (A) are the smaller shirts for children and in box (B), are the bigger shirts for adults. You can go first and find out if you are in the blue or in the red team." To further enhance the emotional involvement with the group (affective commitment) the in-group model expressed joy and satisfaction about the color of their own shirt and engaged the child into celebrating joint group membership by saying: "Yeah, we are in the same team together. We are team blue/red! We are team blue/red!". The out-group-model also reacted positively: "Yeah, I am in team blue/red! I am team blue/red! I am team blue/red!".

In *Condition 3 and 4*: both *maximum group conditions (ineff-in-group / ineff-out-group),* group formation was based on the study by Spielman (2000). He found that 6-year-olds needed a background scenario in which groups were described as preparing to engage in competition in order to show any group-bias. In the present condition, we thus kept all elements from the medium group condition but added another element at the end. The out-group model said: "And later we play again the cotton-blowing game. But this time we play team red against team blue." Then the in-group model encouraged the child: "Yes! That means the two of us as team red/blue play against [Name of the out-group model] in team red/blue."

Please note, that all three group-formation types (*Condition 1: minimal, Condition 2: medium, Condition 3: maximum*) were realized with the inefficient strategy being presented by the in-group model. In addition, the maximum group formation was also realized with the out-group member demonstrating the inefficient strategy (Phase 1) and the in-group member demonstrating the efficient strategy (Phase 2). Therefore, we distinguish the *maximum group conditions* by adding *'ineff- in-group' (Condition 3)* or '*ineff-out-group' (Condition 4).*

Overimitation task. Following the group-formation phase, all children in the experimental conditions took part in two phases of the overimitation task to be described next. Irrespective of group membership, the first demonstration was always performed by the inefficient model (Phase 1) and the second demonstration by the efficient model (Phase 2).

In Phase 1, the child was introduced to the transparent box by the inefficient model, who started the overimitation task in the following way: “Now we are going to play another game. This game is about a special box. There are some more golden marbles in this container. If you can get a marble out, you can exchange it for stickers.” After introducing the container, the efficient model said that he or she had to write something down and sat down at a nearby standing desk facing away from the scene. Then, the inefficient model started the game (“Okay, let’s start. It’s my turn first”). If the child was not paying attention, the model said “Look!” to ensure that the child saw what happened. Then, he/she retrieved a token by using a sequence of causally irrelevant actions (Fig. 1A–D) and a causally relevant action (Fig. 1E): First, the model 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 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 box and the rod. Therefore, two of the irrelevant actions involved physical contact with the testing box (contact-actions) and the other two irrelevant actions did not involve this kind of mechanical contact (no-contact-actions). No model exchanged tokens for stickers. Following the demonstration, the model told the participant that he or she could now retrieve a token on their own however they wanted. Following this instruction, both models left the room. After the child had successfully retrieved a token, both returned to the room and the inefficient model offered to exchange the token for the reward (i.e., stickers).

In Phase 2, the inefficient model sat down at the nearby desk and pretended to write something down, thereby turning his or her back to the scene and not communicating anymore. Meanwhile, the efficient model continued the game by announcing, “Now it is my turn.” Then, the efficient model retrieved a token using only the causally relevant action (Fig. 1E) and subsequently instructed the participant to remove a token however he or she liked, then both models left the room again, reentering the room as soon as the child had retrieved a token and the efficient model helped the child to exchange it for stickers.

Coding and Reliability

An Overimitation-Score (OI-Score) was calculated for each participant by totaling the number of irrelevant actions performed. A score of 0 was allocated to participants who performed no irrelevant actions, with a score of 4 being given for reproduction of all the irrelevant components. Children did get a score of 1 for clapping if they clapped their hands at least once. The lever-pushing action was scored 1, when children pushed the lever at least in 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 scored 1 children had to tap the rod in the palm of their hand at least once or they had to count loudly from one to three. Button-pushing was scored 1 only when children used the rod, not their fingers. The order in which the irrelevant actions were performed was not taken into consideration in the scoring.

Children’s behavior was coded by one of the experimenters based on edited video-recordings showing only the child acting on the container in the absence of the experimenters (so the condition was not discernible). An additional independent coder who was blind to condition, phase and hypotheses also coded each video. High interrater-reliability ($r_{\text{intra-class}}$= .98) confirmed an excellent level of agreement between the two ratings.

Ethical statement

We received ethical clearance from the local ethics committee. Furthermore, we received full informed consent from parents.

Results

All children included in the analyses of the experimental conditions managed to remove a token from the box during Phase 1 of the experiment. Thus, children's behavior was not affected by the experience of failure. We first report results on the effect of our artificial group manipulation before turning to the effects of gender groups.

First step of the analyses: Artificial group manipulations

Eight *t*-tests for independent samples were used to compare each test trial of both phases in all four experimental conditions with the baseline condition. To avoid inflating the Type I error rate, a Holm-Bonferroni correction was applied for all *t*-tests. The adjusted critical alpha level for eight tests was .025. Then we performed two repeated measures ANOVAs. First, we compared all condition with an inefficient in-group and an efficient out-group demonstration (minimal (1), medium (2) and maximum (ineff-in-group) (3)), to see if the rising emphasis of group membership had an effect. Second, we compared both conditions with maximum group emphasis in which the group membership of efficient and inefficient model was reversed (*Condition 3: maximum (ineff- in-group)* & *Condition 4: maximum (ineff-out-group))*.

The number of children showing each of the four non-functional actions in each condition as well as the frequencies of OI-Scores are presented in Table 2. These descriptive analyses show that actions involving physical contact with the puzzle box are performed more frequently than actions not involving this kind of mechanical contact.

Conditions 1-3: In-group model demonstrating the inefficient strategy during Phase 1 and out-group model demonstrating the efficient strategy during Phase 2. OI-Scores of the artificial groups were compared with the baseline condition (see Table 2 and Fig. 2 for means and standard errors) to test if performance of irrelevant actions exceeds exploration behavior.

Condition 1: Minimal group. When group membership was just manipulated by the drawing of t-shirts, children overimitated the inefficient in-group model in Phase 1, t (54) = -6.01, $p < .001$, $d = 1.604$, but their OI-Score dropped to baseline level in Phase 2, t (41.06) = -1.55, $p = .129$, $d = .411$. Thus, children switched to a more efficient strategy when the efficient strategy was presented by an out-group model.

Condition 2: Medium group. If group membership was emphasized through group labels and expressions of joy, children overimitated in Phase 1, t (54) = -7.65, $p < .001$, $d = 2.035$. The OI-Score in Phase 2 dropped, but was still significantly different from baseline level, thus children continued overimitating when the out-group member demonstrated the efficient strategy, t (41.577) = -3.01, $p = .004$, $d = .803$.

Condition 3: Maximum group (ineff-in-group). If group membership was expressed by wearing a specific t-shirt, emphasized through verbal group labels, and made even more salient by emotion expressions and announcing a competition, the mean OI-Score in Phase 1 was significantly higher than that in the baseline condition, thus children overimitated, t (54) = -7.38, $p < .001$, $d = 1.967$. The OI-Score in Phase 2 dropped, but was still significantly different from baseline level, thus children continued to overimitate, t (43.64) = -3.64, $p = .001$, $d = .968$.

Condition 4: Out-group model demonstrating the inefficient strategy during Phase 1 and in-group model demonstrating the efficient strategy during Phase 2 (maximum group (ineff-out-group)). This condition was mainly included to check to what extend overimitation in Phase 1 following an inefficient demonstration, was affected by in-group or out-group-membership of the model. Interestingly, results revealed as similar pattern as before: When the inefficient strategy was demonstrated by the out-group member, the mean OI-Score for Phase 1 was significantly higher than that for the baseline condition. Thus, children overimitated even if the inefficient strategy was presented by an out-group model, Phase 1: t (60) = -9.63, p < .001, d = 2.445. When the efficient strategy was then presented by an in-group model, the OI-Score in Phase 2 dropped, but was still significantly different from baseline level, thus children continued to overimitate. Thus, children did not match their behavior to that of their in-group, Phase 2: t (52.87) = -3.12, p = .003, d = .748.

ANOVA including Conditions 1 - 3: In-group model demonstrating the inefficient strategy during Phase 1 and out-group model demonstrating the efficient strategy during Phase 2. After performing the contrasts reported above, we ran a repeated measure ANOVA with all three experimental in which the in-group model demonstrated the inefficient strategy. We included the between-participants factor Condition (*Condition 1: minimal, Condition 2: medium, Condition 3: maximum (ineff-in-group)*) and the within-participants factor Phase (1 or 2). This analysis revealed a significant main effect for the factor Phase, F(1, 81) = 46.85, p < .001, η^2= .366. However, neither the interaction between Phase and Condition, F(1, 81) = 0.034, p = .966, η^2 = .001, nor the main effect of Condition was significant, F(1, 114) = 1.77, p = .177, η^2 = .042. Thus, conditions did not differ from each other.

ANOVA to compare both conditions with maximum group emphasis (Condition 3: Maximum group (ineff-in-group) & Condition 4: Maximum group (ineff-out-group)).

To test the effects of the group manipulation directly, we compared both maximum group conditions only differing in reversed group membership of the inefficient and efficient model. We ran a repeated measure ANOVA with the between-participants factor Condition (*Condition 3: maximum (ineff-in-group), Condition 4: maximum (ineff-out-group)*) and the within-participants factor Phase (1 or 2). This analysis revealed a significant main effect for the factor Phase, $F(1, 60) = 38.54$, $p < .001$, $\eta^2 = .391$. However, neither the interaction between Phase and Condition, $F(1, 60) = 0.084$, $p = .773$, $\eta^2 = .001$, nor the main effect of Condition was significant, $F(1, 60) = .218$, $p = .642$, $\eta^2 = .004$. Thus, the two maximum conditions did not differ from each other.

Discussion of the first step of analyses

First, we examined the three conditions in which the inefficient strategy was presented by the in-group model and the efficient strategy was presented by the out-group model (*minimum, medium and maximum (ineff-in-group) conditions*). According to comparisons with the baseline, group manipulations seemed to have an effect: As soon as group labels and the expression of joy about being in a team were included (medium group and maximum group conditions) children continued to perform irrelevant actions above baseline-level even after having just observed the most efficient way of getting a reward. The competition announcement (maximum group condition) did not seem to strengthen the effect additionally. In the medium and maximum group conditions children's overimitation slightly decreased after the efficient demonstration of the out-group member, but it was still significantly above baseline-level. Looking at these results we were tempted to conclude that, if only emphasized enough, membership in an artificially formed group does indeed influence children's maintenance of overimitation. However, looking at the comparison involving the two maximum group conditions (ineff-in-group, ineff-out-group) changed that picture.

Strikingly, the pattern of results in the *Condition 3: maximum (ineff-in-group)* looked highly similar to that in *Condition 4: maximum (ineff-out-group)*. Switching group membership of the models did not affect children's tendency to overimitate at all, as supported by ANOVA results comparing both conditions directly. Apparently, it did not matter whether an out-group or an in-group model demonstrated the different strategies. This finding contradicts our initial conclusion.

Second step of analyses: Gender-groups

As stated in the introduction, we also explored whether membership to the pre-existing groups of gender affected children's tendency to overimitate. Since we counterbalanced gender of children and experimenters, we were able to test gender influences of both factors. As our previous analyses demonstrated no substantial effects of artificial group formation on results, we omitted the factor Condition from further analyses and collapsed all artificial group formation conditions in order to increase number of observations per cell as well as statistical power.

Four gender group conditions were created based on the match/ mismatch between child and inefficient and efficient models. As for artificial group effects, eight *t*-tests for independent samples were used to compare each test trial of both phases in all four gender group conditions with the baseline condition. Again, a Holm-Bonferroni correction was applied for all *t*-tests, resulting in a critical alpha level was .025. Then we performed three repeated measures ANOVAs. First, we checked influences of child's and model's gender over all experimental conditions. Second, due to the results of the first ANOVA we performed two ANOVAs to check for the influences of model's gender for boys and girls separately.

Comparison with the baseline condition. OI-Scores for gender groups were compared with the baseline condition (see Table 3 and Fig. 3 for means and standard errors) to test if the level of irrelevant action imitation exceeds exploration behavior.

Inefficient model and child female. If the inefficient model and child were female, girls overimitated in Phase 1, t (54) = -8.79, $p < .001$, d = 2.34, and maintained overimitating after the efficient demonstration of the male model, Phase 2: t (39.67) = -3.63, p = .001, d = .96.

Inefficient model and child male. If the inefficient model and child were male, boys overimitated in Phase 1, t (52) = -7.81, $p < .001$, d = 2.11, and maintained overimitating after the efficient demonstration of the female model, Phase 2: t (39.89) = -3.55, p = .001, d = .98.

Inefficient model female and child male. If the inefficient model was female and the child was male, boys overimitated in Phase 1, t (58) = -9.31, $p < .001$, d = 2.41, and maintained overimitating after the efficient demonstration of the male model, Phase 2: t (51.07) = -3.57, $p < .001$, d = .90.

Inefficient model male and child female. If the inefficient model was male and the child was female, girls overimitated in Phase 1, t (58) = -5.52, $p < .001$, d = 1.43. However, after the efficient demonstration by the female model their OI-Score dropped to baseline level, Phase 2: t (51.94) = -.77, p = .430, d = .20.

ANOVAs for differences of gender groups. We conducted a repeated measures ANOVA with the between-participants factors Inefficient Model's Gender (male/female) and Child's Gender (male/female) and the within-participants factor Phase (1 or 2). This analysis confirmed the significant main effect for the factor Phase, $F(1, 114) = 66.382$, $p < .001$, η^2= .368, with more irrelevant actions being performed in Phase 1 compared to Phase 2. Phase did not interact significantly with gender of child or inefficient model. However, we found significant main effects for the gender of the inefficient experimenter, $F(1, 114) = 6.629$, p = .011, $\eta^2 = .055$; as well as for gender of the child, $F(1, 114) = 4.127$, $p = .045$, $\eta^2 = .035$, as well as a significant interaction effect for gender of child and model, $F(1, 114) = 4.374$, $p = .039$, $\eta^2 = .037$. Thus, the gender-group membership of the model and the child both influenced children's overimitation and revealed substantial interactions.

Descriptive statistics (see Figure 4 and Table 4) revealed that boys in general had slightly higher OI-Scores than girls, and that children copied more irrelevant actions if they were presented by a female experimenter (see Figure 5 and Table 4). Descriptive statistics gave reason to suspect that this effect was mainly driven by girls (see Figure 3). To resolve the significant interaction between gender of child and model we performed two separate repeated measures ANOVAs, one for boys and one for girls, with the within-participant factor Phase (1 or 2) and the between-participants factor Inefficient Model's Gender (male/female). Boys were found to overimitate male and female models equally, $F(1, 56) = 325.84$, $p = .733$, $\eta^2 = .002$, whereas girls overimitated less when the inefficient strategy was demonstrated by a male model, $F(1, 58) = 10.86$, $p = .002$, $\eta^2 = .158$.

Discussion

Culture is characterized by many different group-typical behavior patterns that are transmitted through social learning and instruction. Since overimitation is discussed to be one of the mechanisms allowing for cultural transmission (Nielsen & Tomaselli, 2010), we hypothesized this phenomenon to be sensitive to group membership of model and child. The current study was designed to disentangle the influence of different types of group membership on children's overimitation. More specifically, we tested the influence of artificially formed groups and the pre-existing group gender.

Effects of artificial group membership on overimitation

For the artificially formed groups we manipulated group membership with three different group formation processes. In the *minimal group condition* t-shirts were drawn for group formation, but no further comments were made. That did not affect children's overimitation. As in the study by Hoehl et al. (2014), in which no groups were formed, children overimitated after the demonstration of the inefficient strategy and stopped overimitating after the demonstration of the efficient strategy.

We had expected that children would continue to overimitate after an efficient demonstration (Phase 2) presented by an out-group member. These expected effects of artificial group formation could only be found for the *medium and maximum group (ineff-in-group) conditions*. This finding fits with results of a study on group commitment showing that affective commitment is reliably correlated with displays of in-group favoritism (Ellemers, Kortekaas, & Ouwerkerk, 1999). When the emotional component was included, and children first observed an in-group experimenter performing the inefficient strategy, they overimitated and they continued doing so even after having observed an out-group model performing the efficient strategy. This differed from previous studies with two communicative experimenters but no group-formation process before the start of the demonstration (see Hoehl et al. 2014). The fact that overimitation was maintained even after the efficient strategy had been observed speaks against automatic causal encoding as a mechanism underlying overimitation in the present case. If children imitated irrelevant actions simply because they automatically encode observed actions as causally relevant (Lyons et al., 2011; Lyons, Young, & Keil, 2007), then they should have reduced their overimitation to baseline level following the efficient demonstration. In contrast, explanatory models highlighting the social motivations underlying overimitation would have predicted that children match their behavior to that of the in-group and contrast it to that of the out-group. Our findings partly support this assumption: We found a corresponding pattern for *Condition 2 (medium group)* and *Condition 3 (maximum group (ineff-in-group)*). However, we observed the exact same pattern when the out-group experimenter performed the inefficient strategy and the in-group experimenter performed the efficient strategy in the maximum-group condition. Contrary to our expectations, children overimitated equally whether an in- or and out-group model demonstrated the inefficient strategy during Phase 1 and they did not switch to the efficient strategy even when this strategy was demonstrated by the in-group model during Phase 2. Therefore, we concluded that the actual membership of the inefficient model to the child's group or to the out-group did not influence the child's tendency to copy one over the other.

We propose that the preceding group formation process, not the actual group membership, influenced children's tendency to maintain overimitating. In the medium and in the maximum group conditions (ineff-in-group as well as ineff-out-group) the team formation process included wearing shirts of a certain color, using verbal group labels and the expression of positive emotions and excitement about joint group membership. This process is likely to induce a high motivation, pro-social playful atmosphere and a game-like context. In previous studies with adults it was found that only participants in a positive mood mimic the confederate's behavior (van Baaren, Fockenberg, & Holland, 2006) and that pro-social priming produced a larger automatic imitation (Leighton, Bird, & Heyes, 2009). It is possible that our group-formation process (especially in the medium and maximum group condition) created a positive atmosphere and encouraged the children to maintain overimitating even after having seen the efficient strategy. Further, it is conceivable that the game-like context made children more sensitive for normative and ritualistic behavior.

Overall, our manipulation of artificial group membership induced only minor effects on overimitation rates. Apparently, children did overimitate and kept on doing so in three out of four conditions (these three conditions had the usage of verbal group labels and the expression of positive emotions in common) even after the efficient strategy has been demonstrated, but their overimitation rate did not vary depending on the in- or out-group model showing the inefficient or efficient strategy. Potential reasons related to the general framing of the task and the formation of group-membership will be discussed below, before we take a closer look at the effects of societal group membership.

Situational framing of the task. Legare & Herrmann (2013) proposed that cultural learning in humans involves a “ritual stance” (i.e., trying to find a rationale for actions based on social convention) and an “instrumental stance” (i.e., trying to find a rationale for actions based on physical causation). The difference between rituals and instrumental practices cannot be directly inferred from behavior but is rather a matter of interpretation. “A ritual stance is based on the attribution that an action sequence lacks a physical causal goal and can be triggered by a number of cues, such as start- and end- state equivalence and normative language” (Legare, Wen, Herrmann, & Whitehouse, 2015). Since our overimitation task includes one relevant action in the end (retrieval of a reward), it is not clear whether the task is perceived as more instrumental or ritual. If children did interpret it as being more instrumental, this may explain why their performance was less sensitive to group-formation processes than hypothesized. Given that children participating in another study using the same irrelevant actions (Hoehl e al., 2014) continued to perform these actions after having observed a more efficient method, we doubt that participants in the present study perceived the demonstrated actions as purely instrumental. It was further shown that when instructions are instrumentally framed like stating: “I will show you one way to get the toy out”, overimitation rates are significantly lower than when instructions are conventionally framed by instructions like: "I will show you how to get the toy out” (Keupp, Bancken, Schillmöller, Rakoczy, & Behne, 2016). The instructions we used in the current study (“Now it is your turn. You can get a marble however you like.”) were neutral with respect to their ritual or instrumental nature. In the development of culture, rituals can be seen as irrelevant or inefficient actions that are consistent over time. Hence, actions perceived as rituals might be more influenced by group membership than actions perceived to be instrumental. Future studies may vary this aspect experimentally to clarify the impact of situational framing and group membership with respect to overimitation in young children.

Manipulation of artificial group membership. Our manipulation of group membership was an attempt to create a highly simplified simulation of group structures influencing human cultural transmission. When relating our laboratory setting to group processes in the field, limitations of our group manipulation become evident that deserve further exploration to improve future studies: First, it is conceivable that one person alone is not recognized as an out-group member. According to Tafjel's (1982) definition of groups, two or more individuals need to define themselves as a group. Even small-scale human societies, that develop their own rituals and culture, are usually groups of hundreds to a few thousand. Therefore, it is possible that the groups formed in our experiment were simply too small to elicit an effect relevant for cultural transmission. Therefore, in future studies, it might be interesting to include more individuals in each group to test the relevance of group-formation on overimitation. Second, our models were adults. According to the self-other-control account (Sowden, 2014; Teufel, Fletcher, & Davis, 2010) it is assumed that perceived similarity between agents mediates the effect of group-membership on imitation. Especially for artificially formed groups, it might be more common for children to form such groups with peers than with adults. Testing whether peer-group-membership influences overimitation could provide important information about the role of overimitation in spreading ritual-like behavior within a generation rather than across generations. Third, in all three manipulations of artificial groups children as well as adults were randomly assigned to a given group. (Ellemers et al., 1999) established that, compared to an assigned group affiliation, people tend to feel more committed to self-selected (or achieved) group memberships. Future research could investigate if self-selected group membership has a greater impact on overimitation than randomly assigned group membership. It might be that membership to self-selected groups, assigned groups or pre-existing groups affects cultural transmission differently. Factors like duration of group membership and sense of belonging might also play a role.

Overimitation in the context of societal groups

To address the impact of enduring societal groups, we analyzed the effects of gender of the model and match between the child's and the model's gender on overimitation.

"Real" (pre-existing) group categorizations are supposed to be more salient than artificial, laboratory-created categorizations (see Mullen et al., 1992). Furthermore, in-group identification tends to be higher in pre-existing groups (Ellemers et al., 1999). According to the social identity theory, the extent to which people identify with a particular social group determines their tendency to behave similarly to in-group members (Ellemers et al., 1999). Hence, it is most likely that children identify themselves more with the pre-existing group gender than with an artificial group. Kindergartners put special emphasis on gender membership and often have strong feelings about being a girl or boy, respectively. In nursery school four-year-old children spend three times as much time playing with same-sex children as they do with cross-sex children. At six years of age the ratio of same-sex to opposite-sex play increases to 11:1 (see also La Freniere, Strayer, & Gauthier, 1984; Maccoby & Jacklin, 1987). To test the relevance of gender group-membership on overimitation performance, we used models of different sex and counterbalanced the children's and experimenter's sex. We did not find the expected same-sex group effect. However, a systematic comparison of imitation scores for different gender combinations for child's and inefficient experimenter's gender revealed interesting findings:

First, we found that if irrelevant actions are demonstrated by women children are more likely to copy them. In Germany, most younger children are being taken care of and educated by females before they enter school. For example, the percentage of male kindergarten teachers reached a peak in 2017 with only 5.2% (Statistisches Budesamt, 2017). In the US percentage of male kindergarten teachers is beneath 2.5 % (U.S. Bureau of Labor Statistics, 2016). Therefore, boys and girls are more used to being introduced to cultural rituals and instrumental tools by women than by men. This may lead children of both sexes to put more faith in female models - especially in new situations and interactions with unfamiliar experimenters.

Second, we found that overimitation rates were significantly higher for boys than for girls. The latter result was in line with the recent findings by Frick et al. (2017), who explained these finding with sex differences found in humans for tool use. Boys use more tools when solving a problem than girls (Gredlein & Bjorklund, 2005). Frick and colleagues argue that this might lead to higher attention to objects in boys than in girls thus increasing the likelihood to engage in actions involving these objects. If we look at our baseline condition, we find a slightly higher mean number of performed irrelevant actions in boys ($M = .71$, $SE = .16$) than in girls ($M = .50$, $SD = .17$), supporting the idea that boys felt more intrigued to manipulate the tools in our task than girls, which may also have led to a higher motivation to imitate (and overimitate) a given model.

To fully understand these effects, one needs to also consider the significant interaction between gender of child and inefficient model. When looking at boys and girls separately, we found that boys overimitated at equal rates regardless of whether the irrelevant actions were demonstrated by a male or a female model. However, girls copied irrelevant actions much less if demonstrated by a male model. The fact that only girls show a preference for same-sex models does not fit with same-sex preferences reported in the earlier literature from the 1960s-1980s, usually reporting an effect in the opposite direction: Whereas girls oriented their behavior towards that of female and male models, boys oriented their behavior rather towards male models (Bussey & Bandura, 1984; D. G. Perry & Bussey, 1979). Previous learning experiences with predominantly female caregivers at home and in kindergarten combined with changes in the rigidity of societal gender roles might play a role in this change of results. The current findings have important implications for imitation research in general, because it highlights the necessity to carefully consider gender of model and child when designing studies in this field. More research is needed to investigate in more detail the effects of primary caregiver's and caretaker's gender on imitation in boys and girls. Furthermore, it should be investigated if other pre-existing groups have a similar effect on the transmission of functionally irrelevant behavior.

Taken together, overimitation behavior of 5-year-olds was stronger influenced by gender group membership than by artificial group membership. We propose that the commitment to the pre-existing own-gender group is higher than to the artificial group, the latter being completely new and arbitrary. If children are confronted with the conflict between imitating their in-group member and achieving a given goal in the most efficient way, they tend to overimitate their in-group members only if their commitment to the group is quite strong. Group membership and group commitment or group identification is not the same (Gruber et al., 2017). Therefore, it might be conductive to include assessing group commitment/identification in further studies.

To conclude, we found that membership to an artificially formed group did not affect children's overimitation of in-group vs. out-group members. However, enthusiastic group formation before the overimitation task increased children's tendency to continue to perform irrelevant actions even after observing a more efficient solution. We assume that the playful context and the emotional involvement of children might explain this effect. In contrast to artificial group membership, societal group-membership of the model and the child did affect children's overimitation. More specifically, boys overimitated more frequently than girls and female inefficient models induced more overimitation than male models. In addition, boys tended to overimitate female and male models equally often whereas girls copied irrelevant actions less often when performed by male models than female models. Our findings point to strong effects of both children's and the model's gender as well as the interaction between the two on children's overimitation, which should be taken into account, e.g. through counter-balancing, in future research on overimitation. Given recent changes in the rigidity of societal gender roles and the disparity between our current findings and reports on same-sex imitation from the 1960s-1980s we strongly suggest a renewed research effort into the effects of gender on imitation.

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Tables and Figures

Table 1

Experimental Conditions.

	Group formation	Phase 1: Inefficient demonstration		Phase 2: Efficient demonstration	
Inefficient demonstration – in-group / Efficient demonstration – out-group					
Condition 1: Minimal group	• drawing colored shirts • not further commented	In-group model	Test trial 1	Out-group model	Test trial 2
Condition 2: Medium group	• drawing colored shirts • group labels used • models expressing joy about team membership	In-group model	Test trial 1	Out-group model	Test trial 2
Condition 3: Maximum group	• drawing colored shirts • group labels used • models expressing joy about team membership • announcement of competition between teams	In-group model	Test trial 1	Out-group model	Test trial 2
Inefficient demonstration – out-group / Efficient demonstration – in-group					
Condition 4: Maximum group	• drawing colored shirts • group labels used • models expressing joy about team membership • announcement of competition between teams	Out-group model	Test trial 1	In-group model	Test trial 2

Table 2

Descriptive information for artificially formed groups: number of children who copied each of the four irrelevant actions, mean Overimitation Score and standard error in each condition.

	Frequency of each non-functional action performed				Frequencies of OI-Scores					
Condition	Clapping	Pushing lever	Tapping rod	Pushing button	0	1	2	3	4	Mean OI-Score (SE)
Baseline (*N*=28)	0	14	0	3	13	13	2	0	0	0.61 (0.12)
Inefficient/In-Group – Efficient/Out-Group										
Condition 1: Minimal group (*N*=28)										
Test-trial 1	5	19	8	22	3	4	14	6	1	1.93 (0.19)**
Test-trial 2	2	12	2	12	15	2	7	4	0	1.00 (0.22)
Condition 2: Medium group (without competition) (*N*=28)										
Test-trial 1	6	20	12	27	0	7	10	9	2	2.21 (0.17)**
Test-trial 2	2	13	5	17	9	6	7	6	0	1.36 (0.22)*
Condition 3: Maximum group (with competition) (*N*=28)										
Test-trial 1	8	24	9	24	2	2	13	7	4	2.32 (0.20)**
Test-trial 2	3	17	4	17	6	8	10	3	1	1.46 (0.20)*
Inefficient/Out-Group – Efficient/In-Group										
Condition 4: Maximum group (with competition) (*N*=34)										
Test-trial 1	5	26	15	32	0	5	15	14	0	2.26 (0.12)**
Test-trial 2	2	16	7	19	11	8	8	7	0	1.32 (0.20)*

Note. Asterisks indicate OI-Scores that are significantly greater than those in the baseline condition. * $p < .011$, ** $p < .001$ (critical α is Holm-Bonferroni-corrected, α'=.025).

Table 3

Descriptive information for gender groups: number of children who reenacted each of the four irrelevant actions, mean Overimitation Score and standard error in each condition.

	Frequency of each non-functional action performed				Frequencies of OI-Scores					
Condition	Clapping	Pushing lever	Tapping rod	Pushing button	0	1	2	3	4	Mean OI-Score (SE)
Baseline (*N*=28)	0	14	0	3	13	13	2	0	0	0.61 (0.12)
Inefficient model and child female (*N*=28)										
Test-trial 1	6	21	12	26	0	4	13	9	2	2.32 (0.55)**
Test-trial 2	4	13	7	20	8	5	7	7	1	1.57 (0.24)*
Inefficient model and child male (*N*=26)										
Test-trial 1	7	21	8	23	1	3	12	8	2	2.27 (0.18)**
Test-trial 2	4	17	1	16	0	1	2	3	0	1.46 (0.21)*
Inefficient model female and child male (*N*=32)										
Test-trial 1	7	19	18	28	1	2	13	13	3	2.47 (0.16)**
Test-trial 2	1	18	7	18	0	1	2	3	0	1.41 (0.19)*
Inefficient model male and child female (*N*=28)										
Test-trial 1	4	14	6	3	3	9	14	6	0	1.72 (0.16)**
Test-trial 2	0	10	3	11	0	1	2	3	0	0.78 (0.18)

Note. Asterisks indicate OI-Scores that are significantly greater than those in the baseline condition. * $p < .011$, ** $p < .001$ (critical α is Holm-Bonferroni-corrected, α'=.025).

Table 4

Mean Overimitation Score and standard error across conditions, separated for child's and model's gender.

	Mean OI-Score (SE)	
	Phase 1	Phase 2
Girls	2.00 (0.12)	1.15 (0.16)
Boys	2.38 (0.12)	1.43 (0.14)
Inefficient model female	2.40 (0.11)	1.48 (0.15)
Inefficient model male	1.97 (.12)	1.09 (.14)

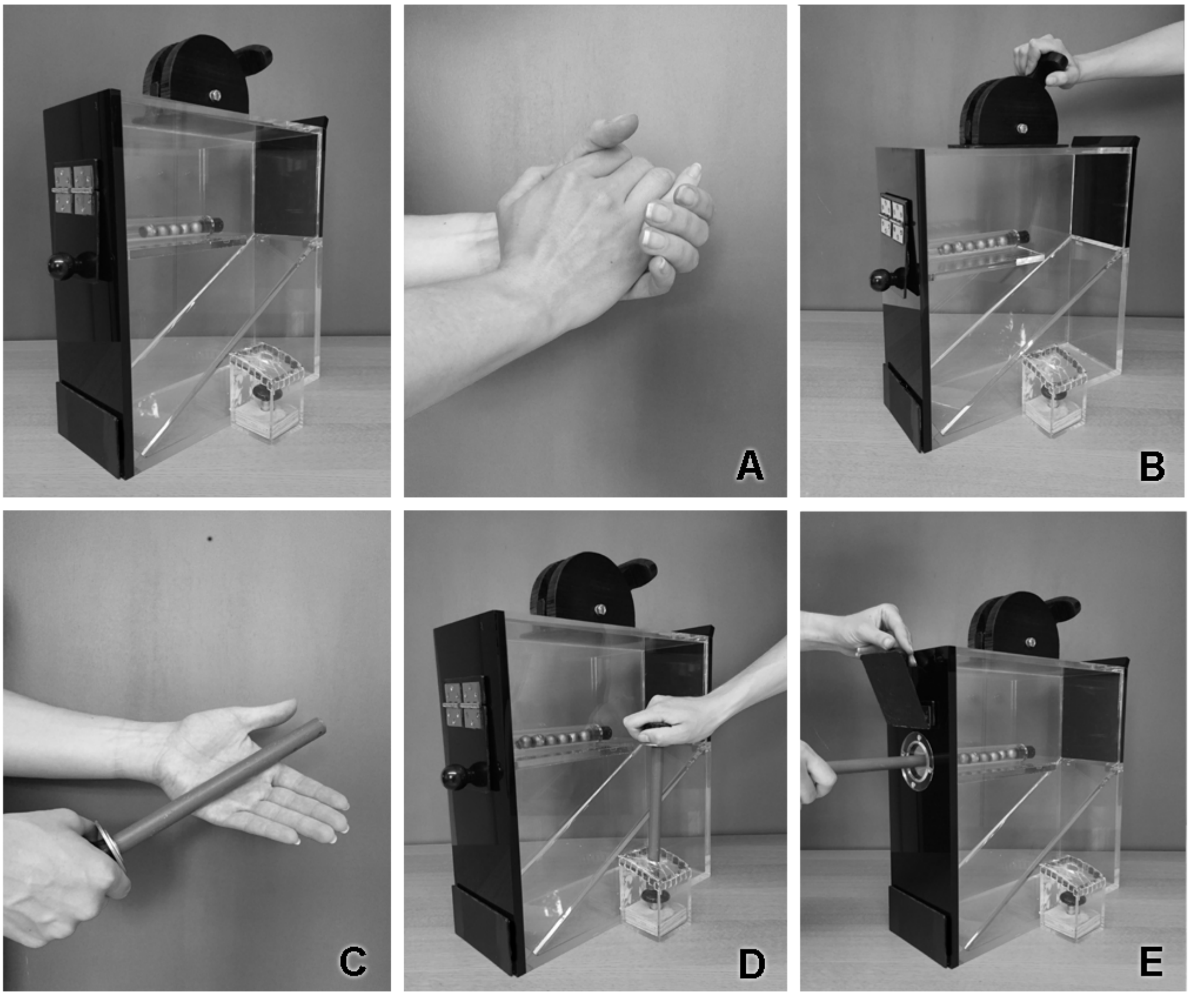

Figure 1. The container and actions performed by the experimenters. Tokens were placed in the transparent tube within the transparent container. The inefficient demonstration consisted of four non-functional actions (A-D) and one functional action (E). The efficient demonstration only consisted of the functional action (E).

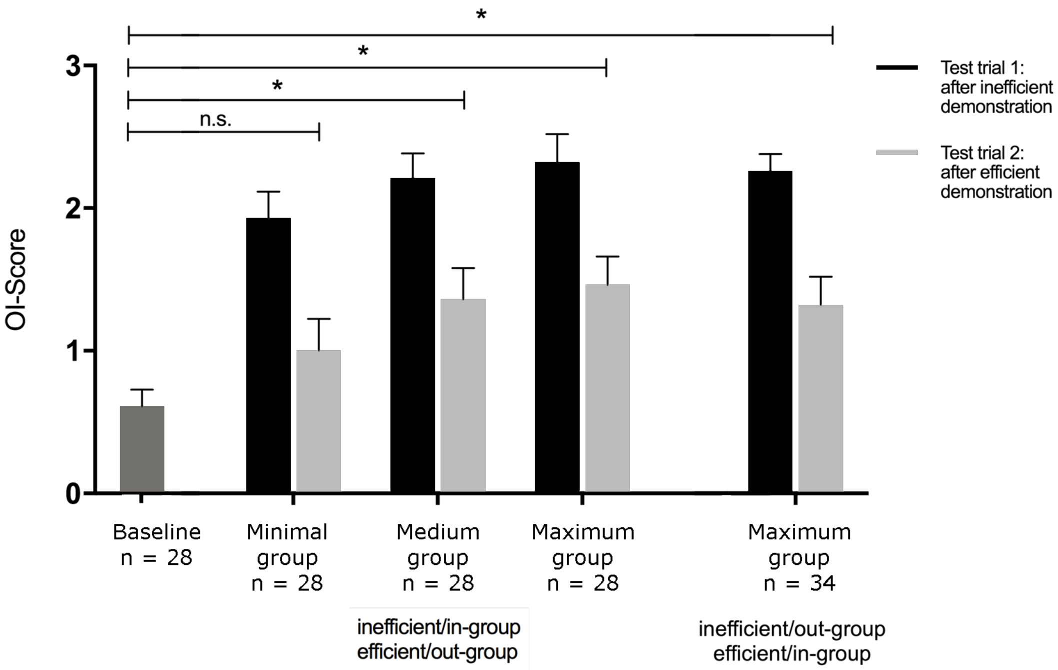

Figure 2. Mean Overimitation Score (OI-Scores) for the artificially formed groups. Error bars indicate standard errors. Asterisks indicate significant differences to the baseline condition. All OI-Scores of Phase 1 were significantly different from Baseline with $p < .001$, therefore only differences between Baseline and Phase 2 are reported in this figure; * $p < .011$ (critical α is Holm-Bonferroni-corrected, α'=.025).

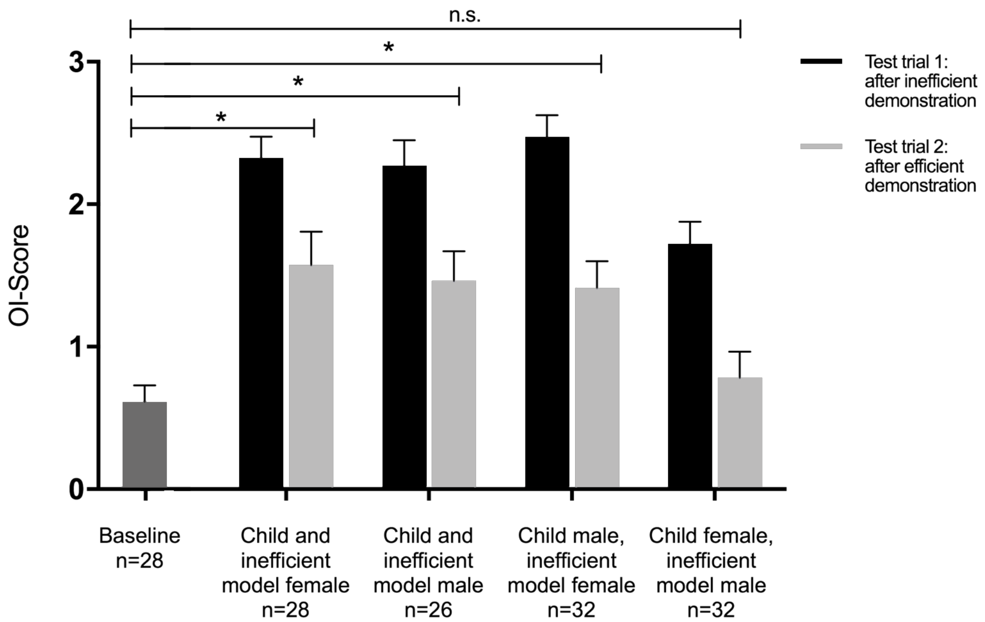

Figure 3. Mean Overimitation Score (OI-Scores) as a function of sex-groups (model's and child's sex). Error bars indicate standard errors. Asterisks indicate significant differences to the baseline condition. All OI-Scores of Phase 1 were significantly different from Baseline with $p < .001$, therefore only differences between Baseline and Phase 2 are reported in this figure; *$p < .011$ (critical α is Holm-Bonferroni-corrected, α'=.025).

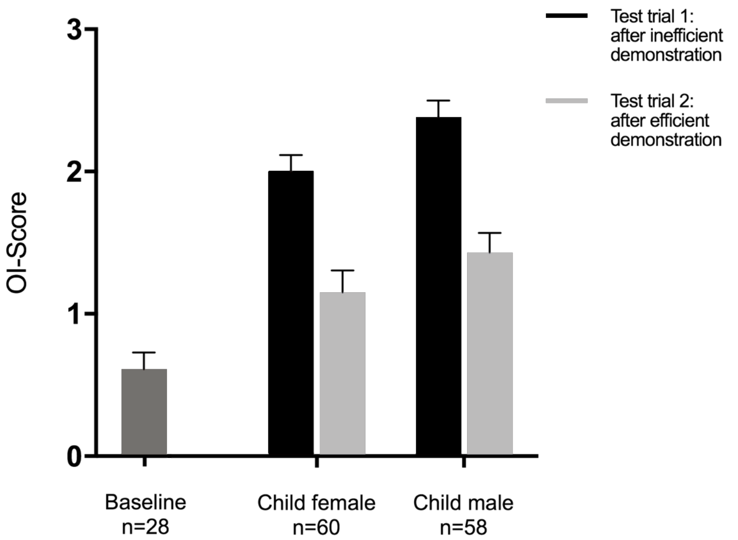

Figure 4. Mean Overimitation Score (OI-Scores) as a function of child's sex.

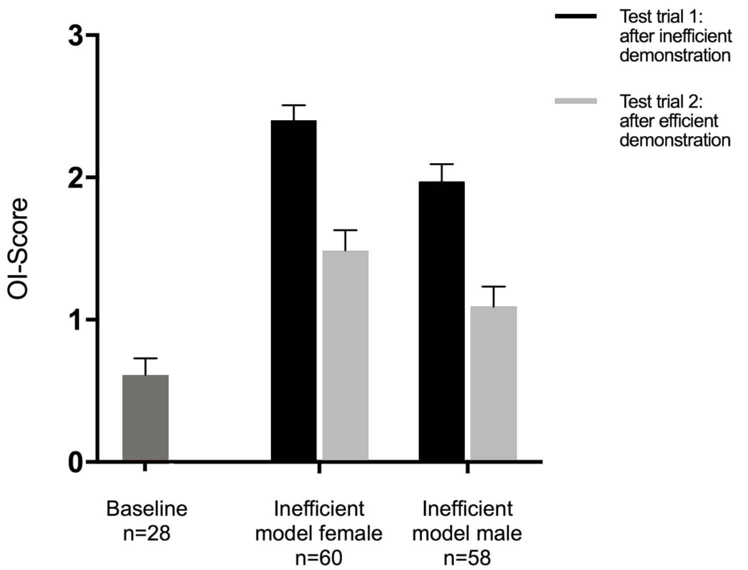

Figure 5. Mean Overimitation Score (OI-Scores) as a function of model's sex.