PRE-SCHOOLERS DO NOT ALWAYS OVERIMITATE: OVERIMITATION AS ACQUISITION OF SHARED ACTION

Tatyana Kotova[a*], Alexey Kotov[b], & Marie Arsalidou[c,d]

[a] Cognitive Research Lab, Russian Academy for National Economy and Public Administration, Moscow, Russian Federation

[b]Laboratory for Cognitive Research, National Research University Higher School of Economics, Moscow, Russian Federation

[c]Psychology Department, National Research University Higher School of Economics, Moscow, Russian Federation

[d]Psychology Department, York University, Toronto, Canada

[*] Corresponding author: Tatyana Kotova, PhD

tkotova@gmail.com

Abstract

Overimitation refers to the tendency of children to reproduce unnecessary actions of adults that often appear markedly irrational, however young children do not always overimitate. In two studies the circumstances under which children overimitate were examined. Hypotheses were framed within a new model of overimitation based on the Acquisition of Shared Action. First, an adult demonstrated relevant and irrelevant actions on a novel object to children 3-5 years old. Second, in two separate experiments interaction conditions (study 1, n=40) and object properties (study 2, n=100) were manipulated. Only specific aspects of the adult-child interaction and the object's physical attributes influenced overimitation. Results are discussed in terms of the rationality and pedagogical principles within the model of Acquisition of Shared Action.

Introduction

Overimitation refers to our tendency to reproduce obvious causally irrelevant actions of others. To date, studies with non-human primates failed to detect overimitation (e.g., Horner & Whiten, 2005). Overimitation appears to be a human specific behavior as this is a phenomenon observed across development; in adults (e.g., McGuigan, Makinson, & Whiten, 2011), school age children (Marsh, Ropar, & Hamilton, 2014), preschoolers (Kotova & Preobrazhenskaja, 2009; Nielsen & Tomaselli, 2010) and toddlers older than 15 months (Hilbrink, Sakkalou, Ellis-Davies, Fowler, & Gattis, 2013; Kotova, Yudina, Kotov, 2014). Young children's overimitation of adult's actions has been mainly attributed to the rationality principle. The rationality principle implies that, within the constraints of a situation, an actor realizes a goal state by the most efficient action available possible (e.g., Gergely & Csibra, 2003). Research shows that following an adult's demonstration, children most often imitate irrelevant actions, even when they can attain the same outcome with fewer task relevant actions, thus violating the rationality principle (e.g., Call, Carpenter, & Tomasello, 2005; Whiten, 2005). Other studies demonstrate that children follow the rationality principle in particular circumstances (Kiraly, Csibra, & Gergely, 2013; Lyons, Young, & Keil, 2007), and explain the children's irrationality in terms of social norms (Keupp, Behne, Zachow, Kasbohm, & Rakoczy, 2015). Schmidt et al., (2011) highlight that a clear interpretation of how children identify parts that are governed by normative rules is lacking. Understanding the influence of rationality on overimitation and its relation to social influences may clarify inconsistencies in the current literature. We propose a new model of mechanisms that underlie overimitation, which we call acquisition of shared action (ASA). Shared action is the mental representation of a past adult-child joint action, during which the novel object was demonstrated to the child by the adult. We then present two studies that examine (a) whether

children's overimitation is affected by the structure (i.e., purpose and object role) of the joint action, and (b) whether children's overimitation differs in terms of functional or external physical properties of an object used during the joint action.

Evidence on overimitation and the rationality principle

Mixed evidence exists on overimitation and its relation to the rationality principle. For instance, 14-month-old infants reproduce the action of an adult illuminating a lamp by touching it with their forehead but do not reproduce the action when an adult does not illuminate the lamp by leaning his or her forehead (Kiraly et al., 2013). Authors concluded that infants could make inferences about observed actions with the help of teleological reasoning, whereas the rationality principle constrained the child from copying the adult's inefficient actions.

Lyons and colleagues (2007) also showed that overimitation did not occur when irrelevant actions were demonstrated on some spatially divided object: an object comprising two distinct halves connected by a tube. Relevant actions were performed on one half of the object and irrelevant actions on the other half. The tube had a gap in the experimental condition but not in the control condition. The children imitated irrelevant actions in the control condition, but they did not imitate the same actions in the gap condition. This suggests that children rationally analyzed relations between actions of the experimenter and the causal object structure. Overall, the aforementioned studies suggest a relation between overestimation and rationality; however, the degree of this relation remains unclear.

Rationality principle in overimitation and alternative interpretations

One alternative account suggests that when children observe an action in the context of ostensive communication, they "try to interpret it in terms of their teleological

representational schema, but they 'suspend' the rationality requirement" (Kiraly et al., 2013, p.13). According to this proposal ostensive communication context sanctions the inclusion of an arbitrary subgoal in the representation of the teleological schema. This is because children expect relevant information in ostensive communications. That means that children use the rationality principle when they choose an action to imitate, but they concede arbitrary means for the final goal because of their lack of knowledge about a novel object.

However, some other studies show that when children can reenact one of two demonstrated actions they do not choose the action by its final outcome (Carpenter, Akhtar, & Tomasello, 1998; Kotova et al., 2014). For example, toddlers between 17 and 20 months prefer to copy an adult's intentional action even if this action is not the result in a positive outcome, but do not copy an adult's accidental action, even if the action ends up with an attractive result (Kotova et al., 2014). This evidence suggests that children would prefer an ostensively cued action, which is consistent with the natural pedagogy approach (Kiraly et al., 2013), and inconsistent with the idea that they "suspend" a rationality requirement. Instead, this finding suggests that a child may choose to "ignore" a rationality requirement.

Another account views imitation in terms of a normative approach (Rakoczy, Warneken, & Tomasello, 2008; Casler, Terziyan, & Greene, 2009; Schmidt, et al., 2011). Normative theory states that children copy unnecessary actions believing they are normative for achieving a desired goal (Kenward, Karlsson, & Persson, 2011; Kenward, 2012; Keupp, Behne, & Rakoczy, 2013; Keupp, et al., 2015). According to this approach overimitation is a result of the formation of a convention, wherein the adult's communicative intention, the pedagogical nature of the message, and the contextual limits are important. Children protesting when a puppet reproduces demonstrated actions, excluding the irrelevant ones, provide evidence of the children's normative attitude to the irrelevant action (Keupp et al., 2013). Nevertheless, we note that norm acquisition theorists do not explain why and how the

norm was acquired (Kenward, 2012). "A critical question that has not so far been answered is how children identify activities and roles that are governed by normative rules." (Schmidt et al., 2011, p. 531). Would a child transfer acquired knowledge about an object's usage to another situation? Would a child reproduce observed irrelevant actions on an object after it was partly transformed? Exploring the above questions will shed light on how the rationality principle contributes to children's imitation, as well as facilitating the understanding of how natural pedagogy moderates this process. A model that frames these constructs together is necessary for hypotheses testing.

ASA-model: overimitation as acquisition of a shared action

Acquisition of Shared Action (ASA) is a model that views overimitation as a result of a child's consent to engage in a joint action initiated by an adult that leads to shared action. We refer to joint action as an immediate here-and-now object based adult-child interaction. Shared action, however, results by experiencing a joint action on a novel object, which is not limited to immediate situations. Shared action, originates from joint action and forms through situations of natural pedagogy. In other words, a shared action persists as children maintain the context of the joint action even after the adult leaves the immediate space.

Fig.1.

A novel object exists and when an adult acts on the object in active interaction with the child this becomes joint action. The child needs to identify the joint action among a multitude of observed events (i.e., actions and non-actions). At this time the child needs to evaluate the situation given rational steps towards making an action and the actions demonstrated by the adult. The former refers to the rationality principle and the latter to the

pedagogical principle (i.e., ostensive cues and natural pedagogy system) in Figure 1. And thus a shared action is formed; children acquire a shared action, analogous to acquiring shared knowledge. In the lack of an adult demonstration the child would use the rationality principle and use the fastest and easiest way to reach his or her goal; here no shared action is formed.

We highlight that the rationality principle has its own role in the formation of shared action but does not define a child's choice to copy or not irrelevant actions. The rationality principle is used to derive an action from experienced events. What defines the choice to copy or not irrelevant actions is the child's investment to the joint action with novel object (i.e., conditions of shared action acquisition). From here, the choice to make or not these irrelevant actions would be defined by the circumstances that call upon the shared action (i.e., the child's purpose is the same as in the previous joint action and the suggested object is looking as suitable as the original object for this action). The circumstances may vary and include any changes in external characteristics of the object and the child's personal purpose. Distinguishing between the mechanisms that are used to create a shared action and the circumstances under which a specific shared action can apply provides additional interpretive power in predicting the degree of overimitation. We used this framework to form our hypotheses in the current study.

Current Study

If the ASA-model is valid, then a child will refrain from reproducing actions that he or she has acquired through overimitation under the following conditions: 1) modification of the joint action with the same object and 2) modification of the object's appearance by making it inappropriate for the joint action. Examples of such modification would include assigning a new role for the same object within a joint action, or assigning a new purpose for the joint

action. To test the model, it is necessary to select aspects of the interaction that do not influence the joint action's structure. The action itself and the motivation behind the action are independent components of any activity. Therefore, according to the ASA-model a child will continue performing irrelevant actions even if there is a change in his or her motivation for using the object. To examine this hypothesis, in Study 1 we varied aspects of subsequent interaction, by manipulating the adult-child interaction, the object's purpose, and the motivation for acting with the object.

In Study 2 we tested the ASA assumption that a child applying the rationality principle only to figure out the adult's action within the general external context. We provided participants with opportunities to transfer the overimitation actions acquired from the original object to a new object. Specifically, Study 2 involved manipulations of the characteristics, which were modified in the new object compared to the original object. We hypothesized that participants would overimitate actions only when the new object shared external features with the original object, whereas modifications in functional properties of the new object were not expected to affect overimitation.

Study 1

Method

Participants

A total of 40 preschoolers were recruited from local day care centers and playgroups in a middle income neighborhood in Moscow. All were Russian children, born to Russian parents. Children ranged in age from 3 years, 10 months to 5 years, 2 months (22 girls and 18 boys, mean age = 4 years, 1 month). Children were tested in a quiet area in the day care center. Parents provided informed consent for their children to participate. All procedures

were approved by the research ethics board at the Russian Presidential Academy of National Economy and Public Administration (RANEPA).

Materials

For the experiment, we introduced three objects, each consisting of several parts, which could be easily transformed. Each object contained a space suitable for the placement of a small toy. For each object, there was a particular action needed for retrieving the toy, which was demonstrated. Additional structural components not related to the toy-retrieving action were mounted on the objects. We designed each unique object to be novel to the children, so that it did not remind them of an experience outside of the experiment.

Object 1 was a rectangular cardboard box containing a toy (Figure 2). One side of this box was a flap, which enclosed the toy within the box, and a red tab was attached to the flap. A round container with a cover was attached to the box. Sticks were fixed to the box's sides.

Fig.2.

Object 2 consisted of two plastic stands, bound by three tubes. There was a plastic card between the tubes. There was a turning wheel inserted in one of the stands. The upper stand contained a yellow ring. The toy was located on a stand and covered with a cone.

Object 3 consisted of a stand in a plastic cup with a hood. A toy was placed on the stand and covered by the hood. There was plastic mesh around the stand, composed by cells that were threaded through a plastic stick. There was a small screw cap on the hood and a piston was mounted on the stand. Thus, we created three objects that met all our requirements that were new to the children, participating in our experiment. The design of

each object provided for the possibility of performing three irrelevant actions that did not interfere with retrieving the toy.

Irrelevant and relevant actions

To recover the toy in Object 1, it was necessary to pull the red tab in order to open the box. This was considered the relevant action (RA). Possible irrelevant actions (IA) in Object 1 included the following: removing the left-side stick (IA1); removing the right-side stick (IA2); removing the cover of the round container (IA3) (see Figure 2).

To recover the toy in Object 2, it was necessary to raise the cone (RA). Possible irrelevant actions in Object 2 were the following: twisting the wheel (IA1); removing the card (IA2); removing the yellow ring (IA3).

To recover the toy in Object 3, a child had to simply raise the hood; this was the relevant action (RA). Possible irrelevant actions in Object 3 were the following: removing the green stick from the mesh (IA1); pulling the piston (IA2); unscrewing the hood's screw cap (IA3).

To verify that children would individually interact with objects without IAs, each of the objects was tested on a separate group of participants (18 preschoolers, mean age = 48 months). In this pre-test we presented the objects to the children with the following phrase: "Look what I have! One can play with this thing in different ways and it has a toy inside. I need to leave you for a while but you can keep playing with it and get the toy in any way you want, any way that is convenient for you." No action demonstration was provided. The results showed that in the absence of actions being demonstrated on the tested objects, all participants discovered the toy in each of our objects while avoiding IA (2 of 18 children performed 2 different irrelevant action). This finding confirms that 4-year-old children can recognize irrelevant actions as unnecessary for toy retrieval using our objects.

Figure 3.

Procedure

We used three objects and each followed the sequence in Figure 3; object order and object-transfer phase were counterbalanced. Adult-child interactions in the transfer phase changed in terms of: (a) purpose of the joint action, (b) object's role within the joint action, and (c) motivation behind the joint action.

Demonstration Phase. This phase was identical for all conditions. The experimenter and child sat at the table opposite each other. After getting acquainted, the experimenter took the object out of the bag while saying the following: "Look what I have here! I can play with this thing in different ways. I might to do this (performing IA1), or do this (performing IA2), and do this (performing IA3), or do this (RA). Look, here is a little fairy (the toy) inside. Now, I need to leave you for a while but you can keep playing with it and get the little fairy in any way you want, any way that is convenient for you." After saying these words, the experimenter re-assembled the object and then left the child for 3-5 minutes. Looking into the room, the experimenter observed whether the child retrieved the toy. After the participant retrieved the toy, the experimenter returned to the room, put the object together, and proceeded to the Transfer phase.

Transfer Phase. The experimenter changed interaction with the child in each of following three condition.

(a) *Changed the purpose of the joint action.* After putting the object together, the experimenter engaged the child in mutual painting activity. When the child seemed to be fully involved in

the process, the experimenter asked the child: "Do you remember whether we put the toy back inside the object? Could you check it, please?"

(b) *Changed the object's role within the joint action.* After putting together the object, the experimenter engaged the child in pretend play. The experimenter directed this play so that it becomes necessary to introduce a fairy; note that the toy inside the object has been introduced as a fairy in this condition. The experimenter did this by pretending to not know where to find such a character, asking: "Oh, now we really need a little fairy to conjure rain, otherwise our flowers will wither! Do you know where we could find a little fairy?" Beforehand, we ensured the absence of a similar toy in the room.

(c) *Changed the motivation behind the joint action.* In this condition, we invited two children, each of whom had previously passed through the Demonstration phase individually, to sit at the table opposite each other, giving them the identical objects and then putting a partition between them. The partition was a 60 cm x 25 cm piece of cardboard with supports, which allowed the children to see each other's faces but concealed their handling the toy. We gave the following instructions: "You have two identical things. You have already played with them, do you remember? Each of these things contains a toy inside, and each of you should get the toy out in as few actions as possible! But you cannot get up from your seat or to peek behind the partition." The word "actions" in the phrase "as few actions as possible" was pronounced with emphasis and eye contact with participants. In this condition, we planned to create a competitive motivation among our participants. We believe we succeeded, as all participants showed at least four out of five signs of competitive behavior: (a) acting with haste, (b) making attempts to peek behind the partition, (c) periodically looking at the face of the other child, (d) demonstrating the found toy to the competitor and experimenter, and (e) expressing joy about having been the first / expressing disappointment about having been the last.

We recorded the number of IA performed by participants while retrieving the toy. The variable was varied between 0 and 3, as each of the objects allowed the performance of three IA in total. We measured performance of IA for each of the participants in each of the conditions at the end of the Demonstration phase and at the end of the Transfer phases. A second observer who was blind to the specific hypotheses of the experiment independently coded children's imitative response for 25% of the data. There was 100% inter-rater agreement.

Results

Fig. 4.

We compared the number of IA performed at the end of the Demonstration phase across the three objects, using the Kruskal-Wallis test. Results showed no significant difference across the three objects ($K = 3.61$; $p > 0.1$). At the end of the Demonstration phase, participants overimitated by copying almost all IA (Figure 4).

Differences in the number of IA between Demonstration and Transfer phases were examined using the Wilcoxon signed-rank test. Results revealed that there was a significant difference between the number of IA at the end of the Demonstration phase and number of IA at the end of the Transfer phase when the purpose of joint action changed ($W = -4.93$; $p < 0.001$, $r = 0.70$; Figure 4) and when the object's role changed ($W = -5.09$; $p < 0.001$, $r = 0.79$; Figure 4), however, no significant difference was observed when motivation changed ($W = -0.97$; $p>0.1$). After we introduced a change of motivation, participants continued to perform the same number of IA as before this change (see Fig. 4).

Discussion

Our results reveal that changing the motivation behind a joint action does not affect the likelihood of children copying irrelevant actions demonstrated by an adult. In contrast, variations in the joint action's purpose and the object's role reduce overimitation. We discuss similarities and differences among the three interaction conditions and the effect they have in eliciting overimitation.

Our data show that overimitation did not persist when the purpose of the joint action was manipulated. When an adult engages a child in play, pretending that it is necessary to find a little fairy inside the object, the object becomes for the child a target in a new situation, for participating in another joint action, with the adult: in this case, looking for a little fairy within the imaginary game. When the child is engaged in drawing with the adult after the object's demonstration, and further, when the adult asks the child to check for the toy's presence inside the object, then the child's purpose in retrieving the toy changes and, therefore, participation in another joint action with the adult takes place: verification of the toy's presence. Neither situation involves reenacting the joint action of using this object as such. In a similar study Lyons et al. (2007) asked children to help verify whether an assistant had put the toys back in the object correctly; in this situation children persist to overimitate. In this situation, the initial joint action remains the same. A differentiation exists between the ritualistic, normative use of the object, and treating it as a plain physical thing. This differentiation is in general agreement with the normative account (Rakoczy, et al., 2008; Casler, et al., 2009; Schmidt, et al., 2011), but in the normative account there is no basis for expecting which circumstance to act with the object (e.g., adult request) would prime a normative response and which would not. Current findings are in agreement with our hypothesis supporting the ASA-model, which assumes that only circumstances when the offer / adult request involves the same action as in the demonstration phase (i.e., with the same goal and the same object′s role), primes the normative use of the object.

In the last motivation condition the adult asked the children explicitly to "make as few actions as possible", however, the children persisted to overimitate. Children were copying practically all IA and RA at maximum speed. This findings are the first to show the effect of motivation on overimitation in pre-schoolers. Our results suggest that because of the competitive emphasis and the children's aspiration to win they count on salient knowledge they gain in the original joint action. Consistent with ASA model predictions, we propose that transformed competitive motivation is still appealing to the same joint action. As the adult guided the children's attention on the initially demonstrated object, the children perceived the extended participation in the joint action with using the object per se, or likely believed that their level of acquired knowledge about the object (i.e., shared action) was being tested.

Study 2

In Study 2, we tested whether the child can generalize overimitating actions from one object to another after a shared action has formed during a child-adult interaction. We predicted that within the overimitation process the rationality principle helps a child detect perceptual characteristics of the adult's demonstrated action (its boundaries, its parts, its subject), however, the child does not apply this principle to the causal validity of the action. We tested this hypothesis by varying the structural aspects of the objects to reveal transfer of the acquired action in situations of overimitation. If the ASA-model holds, then a change in the general causal structure of the object (i.e., functional properties) should not induce any hinderance in the child's ability to transfer the acquired experience to a new situation. We expected that when the child is engaged in the joint action, he or she ignores the "verifying" of the action's rationality but only applies the rationality principle to distinguish adult's

action among other current events. On the contrary, the transfer of experience should be restrained in the condition of modifying the object's external features that visually separate the action with one object from the action with another one, i.e. different actions.

Method

Participants

Participants were 100 preschoolers recruited from local day care centers in a middle income neighborhood in Moscow. All were Russian children, born to Russian parents. Children ranged in age from 3 years, 9 months to 5 years, 3 months (48 girls and 42 boys, mean age = 50 months). We tested our subjects in a quiet place in their preschool or at our laboratory. Parents provided informed consent for their children to participate. All procedures were approved by the research ethics board at the RANEPA.

Materials

Objects in Study 2 adhered to the same requirements as Study 1. Because the purpose of study 2 was to determine the foundation of transferred actions acquired from overimitation, we designed one original object and five corresponding object-doublers. Object-doublers were similar to the original object with specific feature differences (Table 1). Changes in the object's external features refer to changes in visual-spatial attributes of the object (i.e., appearance of body, parts used for IA and locations) handled during the demonstration phase. Changes in the object's functional properties (i.e., causal structure) refer to functional attributes associated with the operations critical for arriving to the solution (i.e., retrieving the toy).

The original object was a blue box with a mounted internal container moved out by a red tab and containing a toy. On the top panel, there was a red stick with a disk 1 cm in

diameter (IA1 involved pulling it); on the left lateral face there was a bracket with a suspended blue ellipsoidal element 2 cm long (IA2 involved moving an element on the bracket); and in the same place there was a stick with a green disk 5 cm in diameter (IA3 involved pulling for it).

Table 1.

To verify that children would individually interact with objects without IAs, each of the five objects was tested on a separate group of participants (15 preschoolers, mean age = 47 months). The children easily discovered the toy in each of our objects while avoiding IA (none of the children realized IA). This preliminary finding confirms that children of the same age as our participants recognize irrelevant actions as unnecessary for the toy retrieving.

Design

The study involved a Demonstration phase and a Transfer phase. The demonstration phase was the same as Study 1. In the Transfer phase we manipulated (a) the objects external features and (b) the objects functional properties, as outlined in Table 1. At the Transfer phase a child was offered one of five object-doublers, named by modified features: (1) «appearance of the body», (2) «parts for IA», (3) «locations of the parts for IA», (4) «mode of IA», (5) «mode of RA» (Table 1), presented to separate groups of children, in a between-subject experiment. Each of the five experimental groups consisted of 20 participants.

Procedure

Demonstration Phase. This phase was identical to Study 1. We carried it out using the original object in all groups.

Transfer Phase. Coming back to the room, the experimenter took away the original object and the retrieved toy. Then the experimenter put the object-doubler on the table and said: "And here I have something else for you! There is a toy inside it again. Now, I need to leave you for a while but you can play with it and get the toy in any way you want, by any way that is convenient for you." The experimenter then left the child for 3 to 5 minutes, acting identically as in the Demonstration phase.

The dependent measure in this experiment was the number of irrelevant actions (IA), varying between 0 and 3. We measured IA for each of the participants in each of the conditions at the end of the Demonstration phase and at the end of the Transfer phase.

Results

When the functional properties of the object were modified, the number of IA performed by a child on the object-doubler compare to the original object was not significantly different ($W = -0.74$; $p > 0.1$; Fig. 4), suggesting that children transfered the way to handle the new object from the original object.

Fig. 5.

However, when the external features of the object were modified the number of IA performed by a child on the object compared to the original object was significantly different ($W = -4.8$; $p < 0.001$, $r = 1.07$; Fig. 4). Across conditions where external features were modified, children did not transfer the acquired actions to the object-doubler, possibly considering it to be new and unrelated to the previously demonstrated original object.

Results of the analyses made for each of the object-doublers individually are also consistent with the external feature/functional property distinction. No significant differences

between the number of IA at the end of the Demonstration phase and at the end of the Transfer phase were observed for the modified Mode of IA ($W = -1.0$, $p > 0.1$) as well as at the modified Mode of RA ($W = -1.07$, $p > 0.1$; Fig. 4), suggesting that children transferred knowledge of acquired actions to the new object. Significant differences between the number of irrelevant actions at the end of Demonstration phase and at the end of Transfer phase were observed for modifications of the Parts for IA ($W = -3.49$; $p < 0.001$; $r = 0.78$), Locations of the parts for IA ($W = -2.66$, $p < 0.01$, $r = 0.60$) and Appearance of the body ($W = -2.07$, $p < 0.05$, $r = 0.46$; Fig. 4), suggesting that children did not transfer knowledge of acquired actions to the new object.

Discussion

Study 2 examined the conditions under which children would persist with overimitating actions on objects that were different from similar objects they observed during the initial joint action. We found that the degree of overimitation decreases when external characteristics of the features (e.g., shape, location of parts) of an object change; however, overimitation persists when the object′s functional properties change. The overimitation may be co-determined by the rationality principle together with pedagogical cues available in a situation, consistent with our hypotheses. The alternative account of rationality principle (Kiraly et al., 2013) could not have predicted results observed in study 2 as this model expects that a child's application of the rationality principle on the choice action to copy would hinder the transfer of the acquired experience between original and new object, which is different in its functional properties. Yet, as predicted by the ASA model, if the rationality principle is applied only for detecting the action among other external events, then the child would refrain from transferring experience to the object with the modified external markers that visually corresponded to the adults' original actions and subgoals.

While observing an adults' actions with objects, a child is able to distinguish effective and non-effective actions (Brugger, Lariviere, Mumme, & Bushnell, 2007), repeated and novel actions (Yang, Bushnell, Buchanson, & Sobel, 2013), and actions that are preparatory for another action or independent goal-directed actions (Carpenter, Call, & Tomasello, 2005). In other words, a child is able to take a teleological stance, described by Gergely and Csibra (Gergely, Nadasdy, Csibra, & Biro, 1995; Gergely & Csibra, 1997; Gergely & Csibra, 2003). Our results contribute to this perspective by adding that children take a teleological stance to detect the adult's action or to figure out its conception, and they do not take a teleological stance to evaluate the utility of the demonstrated action.

Modification of external features in new objects leads to a gradual reduction of IA. Notice the gradual reduction of irrelevant actions across the three types of modification changes, from the parts for IA through the locations of the parts for IA to the appearance of the body (Figure 5). The more the change related to the object parts that were handled by the adult, the more it caused a failure of overimitation on the object-doubler.

A study demonstrated that infants do not always refrain from imitating ineffective actions: if an adult expressed disappointment at the failed action and resumed attempts, the child produced an action that the adult had intended to perform (Meltzoff, 1995). Although, this is not a direct reproduction of the adult's manipulation, the results showed that the infant's action terminated efficiently. We propose that Meltzoff's (1995) finding can be explained by the child's interpretation of the adult's suggested action even in the incomplete demonstration, likely owing to the adult's mime and gestures that express intention, and the child's tendency to imitate all of the demonstrated actions in its "full edition".

General Discussion

In two studies we manipulated interaction and object properties to investigate the occasions and the degree to which overimitation persists. The objectives of our studies were to determine the nature of knowledge received by the child during social learning and to clarify the role of the rationality principle in the overimitation phenomenon.

It is generally accepted that children adapt to social realities within a social learning processes and there are three camps of thought framing overimitation (a) as a failure to apply the rationality principle (b) as a temporal deferral from the rationality principle driven by a pedagogical principle and (c) as a norm acquisition. The child is an active evaluator that appraises the situation and the potential merits for overimitation by employing the rationality principle. Interactions with objects, without any demonstration, show that children can access the toy without any irrelevant actions. According to the ASA-model the child consents to be engaged by an adult into joint action with the object in order to create situations of overimitation. When that occurs the child adapts to the social reality within the social learning process. Note however that children do not always follow the direct verbal instructions from the adult, or observation of adult's explicit behavior, but rather the joint action offered by the adult. Despite clear instructions, the children persisted to overimitate in the motivation condition. In participating in joint action with a novel object, children acquire shared action and use it as a conventional norm. Further in some circumstances, which call upon this shared action (i.e., the same purpose, the same role of the object, the object with the same external features), children reproduse the irrelevant actions. However, preschoolers fail to reproduce irrelevant actions in conditions when the purpose and the object's role change. Similarly, children persist in performing irrelevant actions when the internal functional properties of the objects change, but perform significantly less irrelevant actions when visual external properties of the object changed.

Results support the assumption that preschoolers do not apply the rationality principle to choosing an action when an adult invites them to the joint action, but do apply the rationality principle to identify this action among the multitude of perceived events. Thus, it is not a matter of "suspending" the rationality requirement in the explanation of the overimitation phenomenon (Kiraly et al., 2013), but rather that they assess for a match between the current situation and acquired shared actions and perform accordingly. Worth mentioning is that children up to 6 years of age cannot identify the source of their knowledge (Perner, 1991) or understand the relativity of terminology and categorization that is reflected in essentialism (Gelman, 2003). Both of these abilities are critical for the application of the rationality principle while choosing an action.

Our results reveal that shared actions can exist in pre-schoolers repertoire in the same way that shared knowledge can exist. If a child confronts a novel object and seeks to achieve his or her own objectives, then he or she will tend to apply the principle of rationality while selecting the manner of acting with the object. For example, when a child reaches for scissors for the first time and thereby accidentally discovers that there are sharp parts on it, in the future the child will apply actions towards the scissors properly, turning the sharp parts toward the paper. However, adult's engagement in joint action guides the child to act jointly, wherein the adult is responsible for applying the rationality principle in choosing an action, because the adult is the initiator of the joint activity. Thereafter, as a result of the adult's demonstration of handling the scissors, a child may put his or her fingers in the handle of the scissors, even though it does not ensure his or her success in cutting the paper.

By means of the rationality principle, children may keep track of adults' intentional and accidental manipulations with objects' parts as well as consequent changes in the object, trying to figure out those manipulations that are inherent to the demonstrated action and ignoring the "noise". If an adult is extending his hand to the scissors without performing any

manipulations with them (according to the method in Kiraly et al., 2013), then the child does not imitate this action. We propose here that the rationality principle does not enable a child to distinguish this event as an action because both the evident outcome and the contact with the objects' details are absent.

Such distinction of the role of the rationality principle helps us to identify "units" for a child's representation of normativity; that is, parts of an adult's activities and events, which should be classified as normative. Understanding the units of variation in each situation helps us better address "the question for future conceptual and empirical work as to how exactly young children's awareness of the normativity in collective practices is to be characterized" (Rakoczy et al., 2008, p. 880). Our data shows that overimitation is influenced only by specific aspects of adult-child interaction and the object's physical attributes gained via the initial joint action; thus we propose that acquired norms are actions learned via collective practices.

Overimitation does not occur with familiar objects (Lyons et al., 2007; Pinkham, Jaswal, 2011). The ASA-model proposes that the adult's demonstrated way of acting with the object becomes for a child an integral feature of that object because of the so-called 'generic interpretation bias' (Csibra & Gergely, 2009). The generic interpretation bias refers to the idea that a child perceives any content 'ostensively' demonstrated by an adult as the object's property, whether it is a sound consequence, emotion or functional acting. It becomes characteristic for a novel object to be involved in a certain action (children commonly answer questions regarding an object's nature, e.g.: "What is a brush? – It is a thing we use to paint.").

This approach does not exclude the perception of the object and its properties as parts of the physical reality that are not participating in this action. For example, the "essence" of a paper to be a thing for drawing does not eliminate the possibility of also using the paper for

packing or for making boats and rockets. Analogically, our participants were ready to retrieve the toy out of the object without reproducing the irrelevant actions in the condition when the object was included in another joint action and hence it did not play its “basic” role.

This representation becomes apparent from children’s explanations about their reasons for reproducing demonstrated actions. Most explanations are “normative”: “you should do this” (p. 200, Kenward, 2012). But when adults reason about a norm, they represent its conditional character, that is why children's explanations can not be regarded as completely normative. We propose that the essentialism of children’s categorization supports this proposal. An adult presents to a child the essence of an object, and a child being engaged in joint action with a novel object considers the objects’ name to be the sign for its essence as well for the shared action per se, so a child identifies the other features of the object as consequences of its essence as well.

As the shared action acquisition is an outcome of the child’s and adult’s participation in joint action, the factors that guide children to accept adult’s action as a norm include not only the immediate ostensive cues of demonstrated action but also a broader pragmatic context of the joint action. For instance, Schmidt et al.’s (2011) showed that children imitated experimenter’s actions that were demonstrated without an ostensive communication. However, the broad pragmatic context of this procedure included warm-up tasks with the demonstration of the familiar instrumental actions, and the puppet’s imitations, which often were wrong. This demonstration could lead the children to accept the situation as pedagogical, and consequently, another experimenter’s actions - as normative in scope of this context. Interestingly, if a child witnessed an intentional communication signal addressed to another person, then he or she would aspire to follow the demonstrated actions (Nielsen, Moore, & Mohamedally, 2012). This finding suggests that the role of engaging the child in communication is more important for social learning than addressing him or her directly.

Conclusion

The current results show that preschoolers are sensitive to specific aspects of the adult-child interaction and the object's physical attributes gained via the initial joint action, when they imitate. Particularly, preschoolers will overimitate when the motivation for the action and functional properties (i.e., causal structure) of the object changes. However, they will not overimitate when the purpose of action, and the role of the object and its parts in this action are changed. Whether different components of pragmatic context of a joint action would be important for different age groups is an outstanding question for future research.

The ASA-model, introduced here, provides an explanation of the partial use of the rationality principle in the imitation process. The current data show that children did not apply the rationality principle when "verifying" an action's rationality, but they applied this principle as a particular detector of the action and of the action's structure, when identifying the joint action among a multitude of perceived events. This distinction helps to explain some discrepancies in the data about selective and faithful imitation (e.g., Kiraly et al., 2013; Marsh et al., 2014; Over & Carpenter, 2013 for review; Schmidt et al., 2011).

The ASA-model also defines how children identify "normative" elements of demonstrated activities of adults: children look for the adults' action and ignore sub-actions, accidental movements or other perceived events that are not included in the structure of the action. Such approach can clarify the questions about why and how the norm was acquired (Kenward, 2012) in all fields where social learning in the formation of a convention is studied.

Overall, the current studies have practical and theoretical implications in the field. Future studies investigating overimitation can benefit from considering the various

dimensions of variation that influence overimitation as presented by the ASA model. Theoretically, the ASA model provides a comprehensive option for hypotheses testing and data interpretation on overimitation and social learning in general.

Acknowledgements

This research was supported by RHF according to the research project №15-06-10943. We thank Anna Preobrajenskaya and Maria Spiridonova for assistance in collecting and coding the data, as well as to all daycare centers and children for their friendly cooperation.

References

Brugger, A., Lariviere, L. A., Mumme, D. L., & Bushnell, E. W. (2007). Doing the right thing: Infants' selection of actions to imitate from observed event sequences. *Child development*, *78*(3), 806-824.

Call, J., Carpenter, M., & Tomasello, M. (2005). Copying results and copying actions in the process of social learning: chimpanzees (Pan troglodytes) and human children (Homo sapiens). *Animal Cognition*, *8*(3), 151–63.

Carpenter, M., Akhtar, N., & Tomasello, M. (1998). Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development*, *21*(2), 315–330.

Carpenter, M., Call, J., & Tomasello, M. (2005). Twelve- and 18-month-olds copy actions in terms of goals. *Developmental Science*, *8*(1), 13–20.

Casler, K., Terziyan, T., & Greene, K. (2009). Toddlers view artifact function normatively. *Cognitive Development*, *24*(3), 240–247.

Csibra, G., & Gergely, G. (2006). Social learning and social cognition: The case for pedagogy. *Processes of change in brain and cognitive development. Attention and performance XXI*, *21*, 249-274.

Csibra, G., & Gergely, G. (2009). Natural pedagogy. *Trends in Cognitive Sciences*, *13*(4), 148–53.

Gelman, S. A. (2003). *The essential child: Origins of essentialism in everyday thought*. Oxford University Press.

Gergely, G., & Csibra, G. (1997). Teleological reasoning in infancy: the infant's naive theory of rational action. A reply to Premack and Premack. *Cognition*, *63*(2), 227–33.

Gergely, G., & Csibra, G. (2003). Teleological reasoning in infancy: the naïve theory of rational action. *Trends in Cognitive Sciences*, *7*(7), 287–292.

Gergely, G., Egyed, K. and Király, I. (2007). On pedagogy. Developmental Science, 10: 139–146.

Gergely, G., Nádasdy, Z., Csibra, G., & Bíró, S. (1995). Taking the intentional stance at 12 months of age. *Cognition*, *56*(2), 165–93.

Hilbrink, E. E., Sakkalou, E., Ellis-Davies, K., Fowler, N. C., & Gattis, M. (2013). Selective and faithful imitation at 12 and 15 months. Developmental Science, 16(6), 828-840. doi:10.1111/desc.12070

Horner, V., & Whiten, A. (2004). Causal knowledge and imitation/emulation switching in chimpanzees (Pan troglodytes) and children (Homo sapiens). Anim Cogn, 8(3), 164–181. doi:10.1007/s10071-004-0239-6

Kenward, B. (2012). Over-imitating preschoolers believe unnecessary actions are normative and enforce their performance by a third party. Journal of Experimental Child Psychology, 112, 195–207.

Kenward, B., Karlsson, M., & Persson, J. (2011). Over-imitation is better explained by norm learning than by distorted causal learning. *Proceedings. Biological Sciences / The Royal Society*, *278*(1709), 1239–46.

Keupp, S., Behne, T., & Rakoczy, H. (2013). Why do children overimitate? Normativity is crucial. *Journal of Experimental Child Psychology*, *116*(2), 392–406.

Keupp, S., Behne, T., Zachow, J., Kasbohm, A., & Rakoczy, H. (2015). Overimitation is not automatic: Context sensitivity in children's overimitation and action interpretation of causally irrelevant actions. Journal of Experimental Child Psychology, 130, 163-175.

Király, I., Csibra, G., & Gergely, G. (2013). Beyond rational imitation: learning arbitrary means actions from communicative demonstrations. *Journal of Experimental Child Psychology*, *116*(2), 471–86.

Kotova T.N., & Preobrazhenskaja A.D. (2009) Rol' namerenija vzroslogo v jeffekte chrezmernogo podrazhanija. «Psihologija. Zhurnal VShJe», №1, 2009./ Kotova T.N., Preobrazhenskaja A.D. (2009) The role of adult's intention in the overimitation effect. Psychology. Journal of Higher School of Economics, Vol. 6, № 1, pp.152-159

Kotova, T.N., Yudina, T.O., & Kotov, A.A. (2014) The influences of intentionality and effectiveness of adults' behavior on infants' imitation of object-related actions. *The Russian Journal of Cognitive Science*, vol. 1 (1–2), pp. 39–53.

Lyons, D. E., Young, A. G., & Keil, F. C. (2007). The hidden structure of overimitation. *Proceedings of the National Academy of Sciences of the United States of America*, *104*(50), 19751–6.

Marsh, L. E., Ropar, D., & Hamilton, A. F. de C. (2014). The Social Modulation of Imitation Fidelity in School-Age Children. PLoS ONE, 9(1), e86127. doi:10.1371/journal.pone.0086127

Meltzoff, A. N. (1995). Understanding the intentions of others: re-enactment of intended acts by 18-month-old children. *Developmental psychology*, *31*(5), 838.

McGuigan, N., Makinson, J., & Whiten, A. (2011). From over-imitation to super-copying: Adults imitate causally irrelevant aspects of tool use with higher fidelity than young children. British Journal of Psychology, 102(1), 1–18. doi:10.1348/000712610x493115

Nielsen, M. (2006). Copying actions and copying outcomes: Social learning through the second year. Developmental *Psychology, 42*(3)*, 555–565.*

Nielsen, M., & Blank, C. (2011). Imitation in young children: When who gets copied is more important than what gets copied. *Developmental Psychology,47*, 1050-1053.

Nielsen, M., Moore, C., & Mohamedally, J. (2012). Young children overimitate in third-party contexts. *Journal of Experimental Child Psychology*, *112*(1), 73–83.

Nielsen, M., & Tomaselli, K. (2010). Overimitation in Kalahari Bushman children and the origins of human cultural cognition. Psychological Science, 21, 729–736.

Over, H. and Carpenter, M. (2013). The Social Side of Imitation. Child Development Perspectives, 7: 6–11.

Perner, J. (1991). *Understanding the representational mind*. The MIT Press.

Pinkham, A. M., & Jaswal, V. K. (2010). Watch and Learn? Infants Privilege Efficiency over Pedagogy during Imitative Learning. *Infancy*, *16*(5), 535–544.

Rakoczy, H., Warneken, F., & Tomasello, M. (2008). The sources of normativity: young children's awareness of the normative structure of games. *Developmental Psychology*, *44*(3), 875–81.

Schmidt, M. F. H., Rakoczy, H., & Tomasello, M. (2011). Young children attribute normativity to novel actions without pedagogy or normative language. *Developmental Science*, *14*(3), 530–9.

Sperber, D., & Wilson, D. (1986). *Relevance: Communication and Cognition*. Harvard University Press.

Whiten, A. (2005). The second inheritance system of chimpanzees and humans. *Nature,* 437, 52-55.

Wilks, M., Collier-Baker, E. and Nielsen, M. (2015). Preschool children favor copying a successful individual over an unsuccessful group. Developmental Science, 18: 1014–1024.

Woodward, A. L. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition*, *69*(1), 1–34.

Woodward, A. L. (2003). Infants' developing understanding of the link between looker and object. *Developmental Science*, *6*(3), 297-311.

Yang, D. J., Bushnell, E. W., Buchanan, D. W., & Sobel, D. M. (2013). Infants' use of contextual cues in the generalization of effective actions from imitation. *Journal of Experimental Child Psychology*, *116*(2), 510–31.

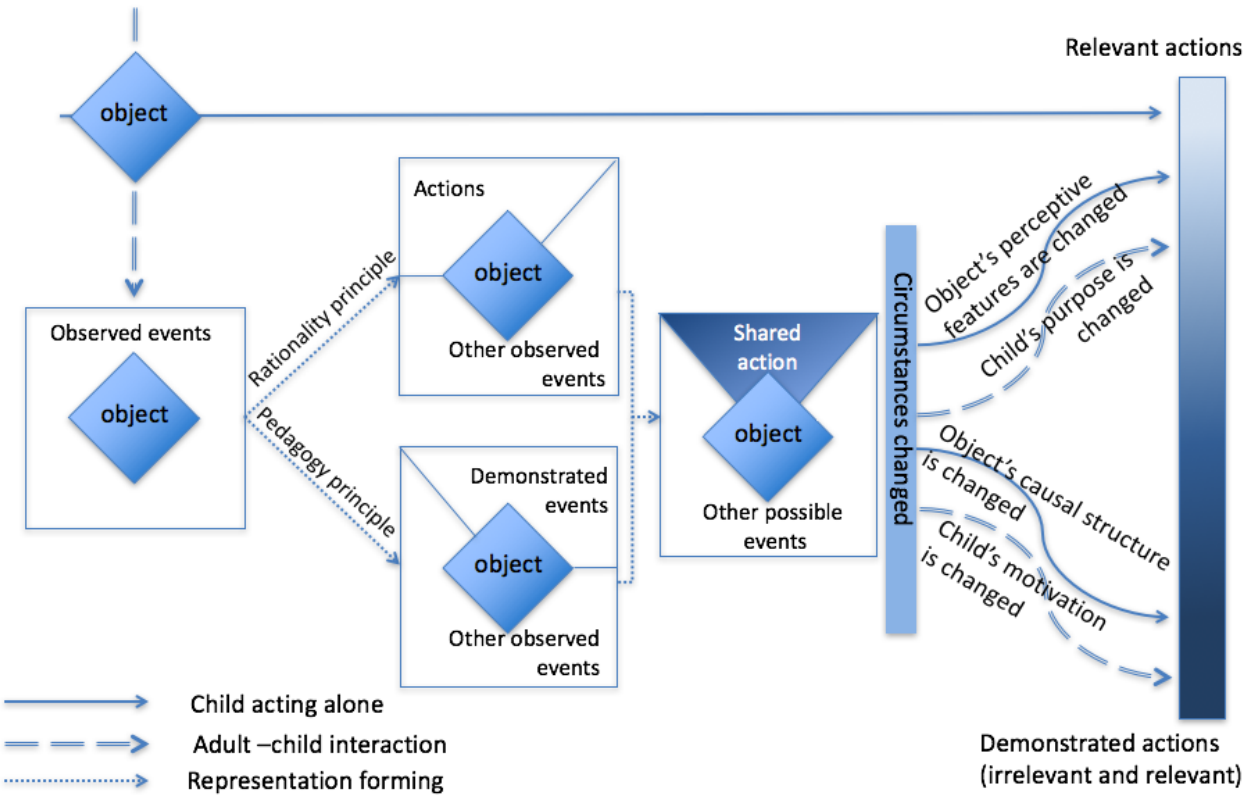

Figure 1. Simplified illustration of the Acquisition of Shared Action (ASA). Sequential model of events during which joint action becomes shared action and the circumstances that call upon the shared action subsequently.

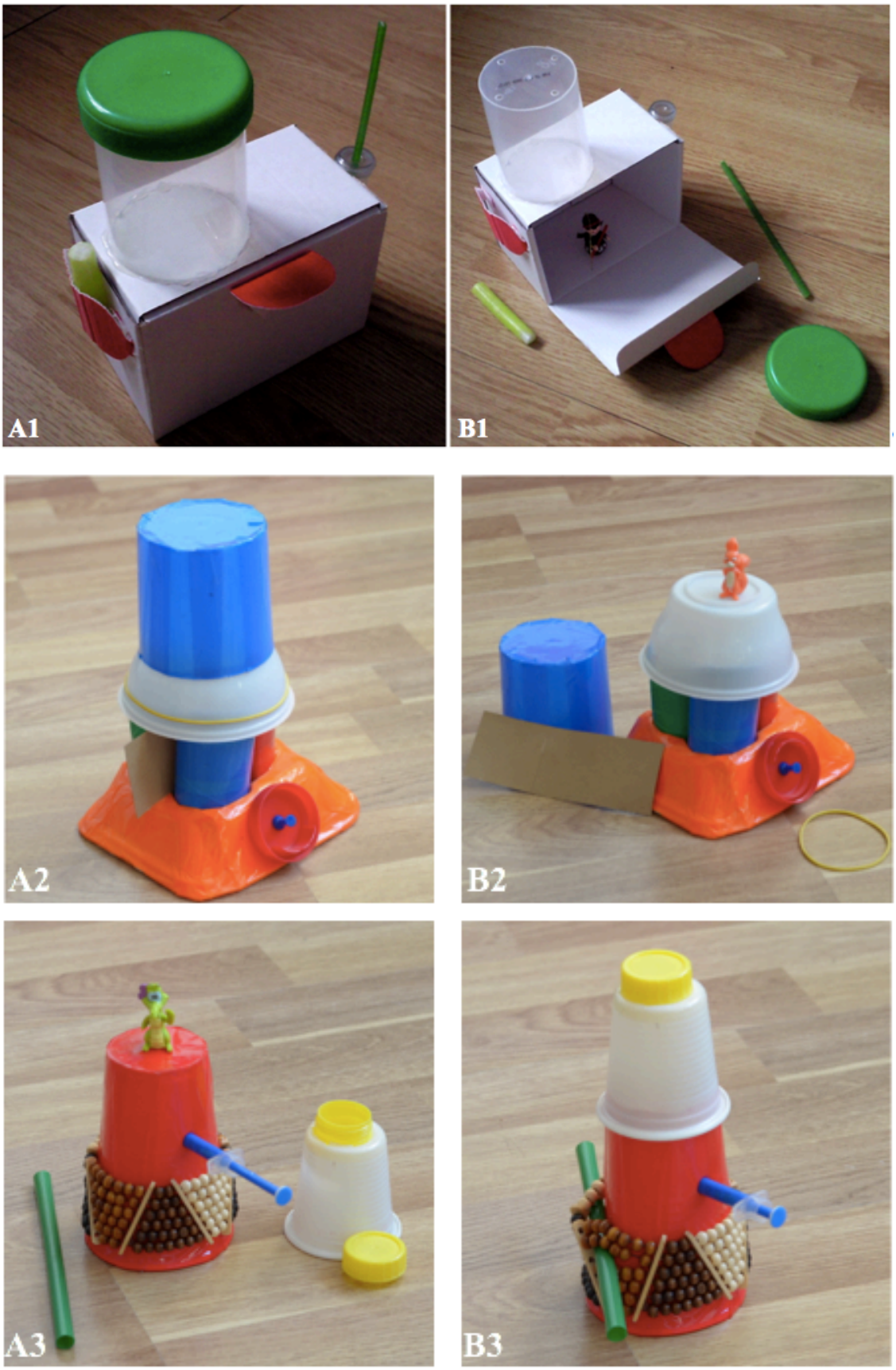

Figure 2. Objects 1, 2, 3: (A) Before- and (B) after- performance of the irrelevant and relevant actions.

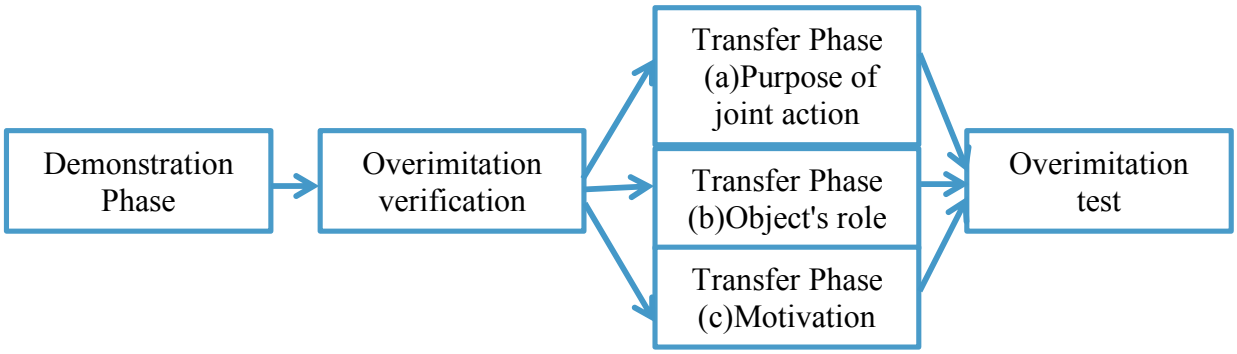

Figure 3. Study design: For each of the three conditions we included a Demonstration Phase, an Overimitation verification, a Transfer Phase, where different aspects (a), (b) and (c) of the interaction were changed, and an Overimitation test.

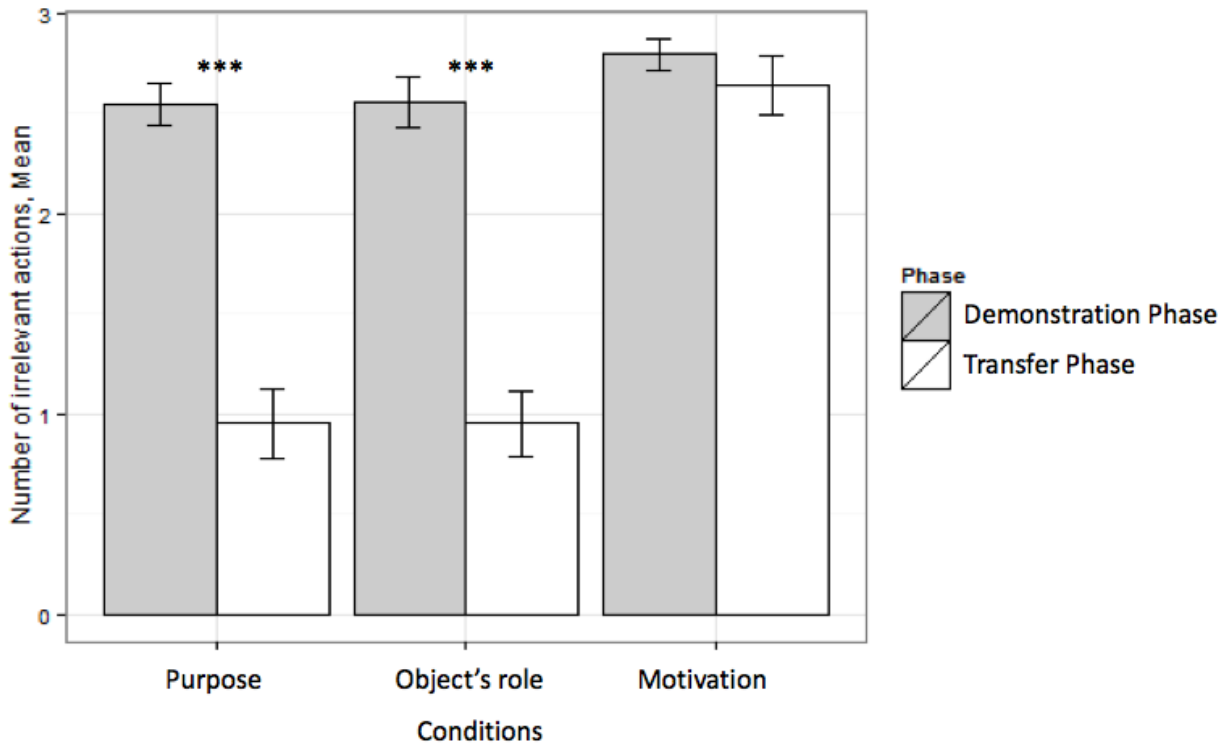

Figure 4. Comparison of the number of irrelevant actions during Demonstration phase (grey bars) and during Transfer phase (white bars) under different conditions where we changed (a) the *purpose of the joint action* (Purpose), (b) the *object's role within the joint action* (Object's role), and (c) the *motivation behind the joint action* (Motivation).

Modification of	Feature Manipulation	Object-doubler	Original object
Object's external features	1«Appearance of the body»	Object's body is a yellow cylinder	Object's body is a blue box
	2 «Parts for IA»	On the top panel, the black stick with a round handle 3 cm in diameter; on the left lateral face, a bracket with the ring suspended on it with a violet figure; and on the same place a stick with a gray figure.	On the top panel, the red stick with a disk 1 cm in diameter; on the left lateral face, a bracket with a suspended blue ellipsoidal element 2 cm long; and in the same place there was a stick with a green disk 5 cm in diameter.
	3«Locations of the parts for IA»	The red stick with a disk of 1 cm in the diameter on the right lateral face; bracket with blue ellipsoidal element 2 cm long suspended on it on the front; the stick with a green disk 5 cm in diameter on the top.	The red stick with a disk of 1 cm in the diameter on the top panel; bracket with blue ellipsoidal element 2 cm long suspended on it on the left lateral face; the stick with a green disk 5 cm in diameter on the left lateral face.
Object's functional properties	4«Mode of IA»	IA1: to move the red stick with a disk of 1 cm in diameter from right to left (the stick itself cannot be physically extracted). IA2: to remove from a bracket the blue ellipsoidal element 2 cm long (it cannot be moved on a bracket physically). IA3: to turn off a green disk 5 cm in diameter (as the stick itself cannot be physically extracted).	IA1: to pull red stick with a disk 1 cm in diameter. IA2: to move the blue ellipsoidal element 2 cm long on the bracket. IA3: to pull the stick with a green disk 5 cm in diameter.

	5«Mode of RA»	To get the toy out of the object, it is necessary to turn a small red cover on the front of the object.	To get the toy out of the object, it is necessary to move out internal container by a red tab on the front of the object.

Table 1. The description of object-doublers.

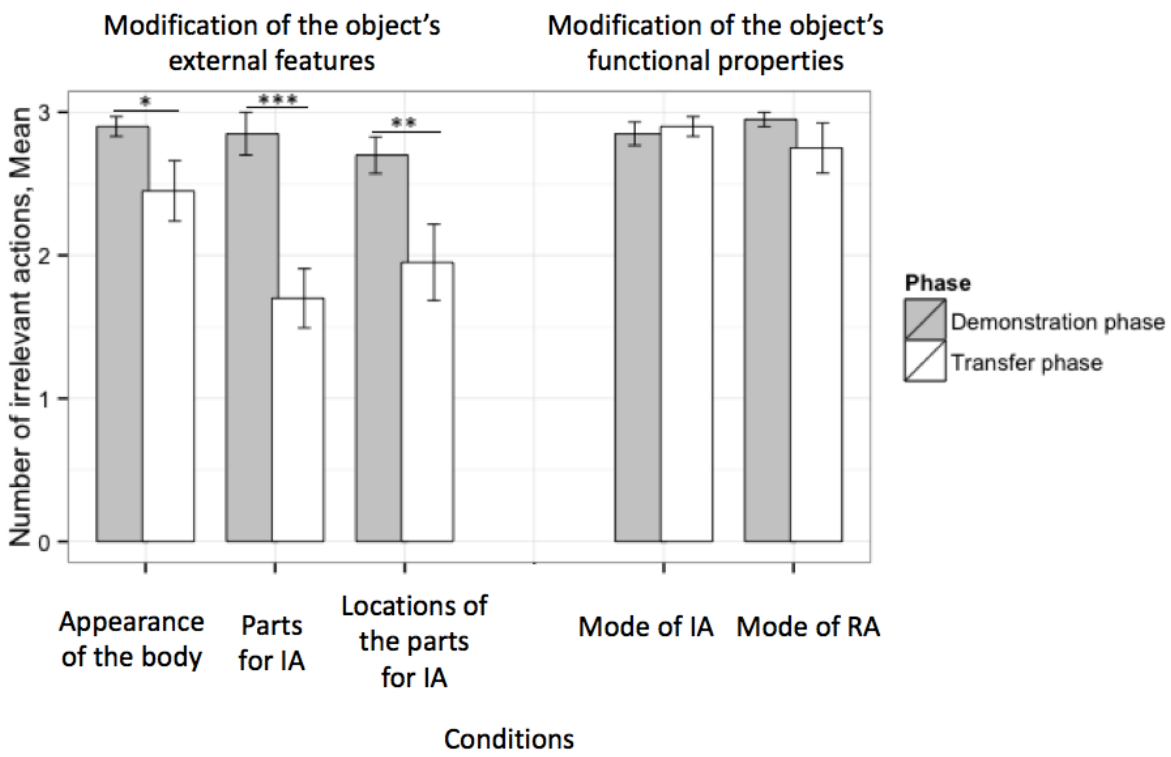

Figure 5. Comparison of the number of irrelevant actions on original object during demonstration phase (grey bars) and on object-doublers (Table 1) during Transfer phase (white bars).