



The influences of intentionality and effectiveness of adults' behavior on infants' imitation of object-related actions

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Аннотация

In the second year of life, infants are actively interested in objects used by adults, despite the number of experienced difficulties in achieving their goals while handling these objects. What causes the child attempt to handle an object for a designated purpose while watching the adult? One of the evident explanations concerns the effectiveness of the adults behavior and the child's desire to achieve the same result. However, multiple studies have shown that a child is guided not exclusively by the hoped-for result, but also by the adults intention. In our study, we verified the reason guiding a child's choice in an ambiguous condition modeled by situations which contrast intentional and effective adult behavior. We discovered that infants between 17 and 20 months old preferred to copy an adult's intentional action even if this action did not result in positive outcome, but did not copy an adult's accidental action, even if the action ended up with an attractive result. However, the child's tendency to follow the adult's intention develops during the process of growing, as no similar pattern is observed in children between 12 and 16 months old. Here we also discuss this phenomenon in terms of its relation to the existing data on the overimitation effect and the age range of its manifestation. The current study provides a view of social learning development which is an alternative to the traditional view which treats social learning only as an increase in the complexity of acquired actions with age. Our results suggest that what changes with development is that actions learned and demonstrated by the child become more and more relevant to planning and control of behavior.

Ключевые слова: action planning, social learning, infant's imitation, object-related actions, effectiveness, intentionality



Introduction

The core problem in the research field of object-related activity in children is uncertainty about the reasons for object usage; it is not clear why children use object-related actions and what benefit they obtain (Jel'konin, 1997a). Until small children acquire the correct way to use a new object, they achieve better results without it. For example, an initial inept handling of a spoon for eating is significantly less effective compared to direct hand delivery of food to the mouth; it is also initially easier to use a finger to draw a circle than to attempt to use a pencil for the same task in the early period of childhood. Nevertheless, the toddler reaches for the objects with enthusiasm and persistence, trying to handle them the same way as they are used by adults. This fact raises assumptions that a child is acquiring the manner to act with the novel objects not just for effectiveness, but rather basing on their meaning for others (Jel'konin, 1997a; Uzgiris, 1981; Keupp, Behne, & Rakoczy, 2013).

However, the child's particular way to figure out such a meaning remains hidden for developmental psychologists. Recent investigations of a child's ability to identify an adult's intention aimed at the discovery of its origins (Meltzoff, 1988; Carpenter, Call, & Tomasello, 2002; Gergely & Csibra, 2003). In fact, an adult's object-related actions are almost always intentional, and thus, the deliberate manipulations on an artifact precisely reveal its cultural function. To illustrate this point, consider that an infant may observe an adult touching a spoon accidentally while removing it along with other objects off the table, but in order to learn to use a spoon purposefully, a child needs to distinguish the food-related actions performed by the adult. What are the limits of this ability for an infant?

A number of empirical studies show evidence for an early competence of 3 to 6-months-old infants to determine the intentionality of adults (Woodward, 1998; Woodward, Sommerville, & Guajardo, 2001). In these studies, the experimenters employed a habituation paradigm by demonstrating repeatedly grasping arm actions on two reachable toys with fixed positions. Then, the objects' positions were reversed and infants viewed two kinds of test trials: during new-goal trials, an adult reached toward the same location to grasp the new object; thus, her physical movements were the same, but her goal had changed. On new-side trials, the person reached



toward the other side to grasp the same object; thus, she moved in a new direction, but still acted on the same goal. The results revealed that children showed a stronger visual novelty response during new-goal trials than on new-side trials. This proves that an infant is able to distinguish an action's direction and goal; that is the child can interpret the adult's actions in terms of intentional relations.

It is worth mentioning that the goal of a grasping action is visually presented and relatively obvious, so understanding the goal in this case is quite easy for an infant if she reads human movements as intentional. However, it is more complicated when it comes to the attribution of intentionality to the higher order manipulations performed by adults, because adults execute multiple movements while handling the same object, wherein these movements may represent parts of complex goal-directed actions, independent intentional actions or indirect movements included as part of an intentional action with another object. For example, in an experiment by Carpenter, Call, and Tomasello (2005), toddlers watched how an adult moved a toy mouse from one table edge to another using one of two action styles: hopping ("beebabee"), or sliding ("beeeee"). In one of conditions there were two houses at the end of a table, and the mouse as a result of its movement reached one of them, in the other condition there were no houses and the mouse simply crossed a table. After the instruction "Your turn", the method of movement of a mouse (hopping or sliding) was repeated only by children from the second group. The children, seeing how the mouse got to the house, applied casual options of movement, which did not correspond to the action style. Thus, the authors concluded that at the age of 12 months the child understands the intention of this or that manipulation with an object — whether it is an independent action (to jump / to slide a mouse) or an intermediate, operation for other action (to place a mouse in the right or left house) — instead of, and in this sense, whether the action is worth copying.

As a whole, modern experiments have proven an infant's ability to imitate intended actions regardless of whether the outcome is actually observed (Meltzoff, 1988; Gergely, Bekkering, & Király, 2002; see review in Sergienko, 2006). However, infants observe intentional adult behavior, which usually turns out to be effective. Therefore, we hereby face the question of whether infants are guided by the outcome of an adult's goal-directed action or rather by the mere fact that the observed action is intentional. For example, Carpenter, Akhtar, and Tomasello (Carpenter et al., 1998) conducted



an experiment in which infants observed a model's intentional and accidental actions, where both types of actions had positive effective outcomes. A demonstrator carried out manipulations on the objects, which consisted of two mobile parts and was specially made for this test. Results showed that, infants copied more of the adult's intentional than accidental actions, although both actions were effective.

Still, the results mentioned above do not clarify existing doubts about whether rationality influences the infant's choice to follow an adult's intentionality or not. It is possible, as demonstrated in the experiment by Carpenter et al. (1998), that children imitated the intentional actions because of their efficacy, considering such an intention as a bonus; that is, effective actions per se possessed some extra attractive properties, which encouraged the infant to copy it.

Thus, while considering Carpenter and colleagues' study, it remains of interest to find out whether an infant imitates the adult's intentional action in case of no observed relation to its result. Such an opposing condition is widely studied within the research on the so-called overimitation effect (Whiten, Custance, Gomez, Texidor, & Bard, 1996; Call, Carpenter, & Tomasello, 2005; Lyons, Young, & Keil, 2007; Keupp, Behne, & Rakoczy, 2013; Kiraly, Csibra, & Gergely, 2013). Most of the studies describe the overimitation effect in preschoolers (see review in Kotova & Kotov, 2014), but we consider here Nielson's research of infants (2006).

In Nielson's study, 12-, 18-, and 24-month-olds watched an adult retrieving a toy from a closed box by disengaging a switch located on the front of the box (Nielsen, 2006). Although the box could be easily opened by hand, the adult complicated the demonstration by using an additional object to operate the switch; that is, the adult performed redundant actions according to the usual testing within the overimitation paradigm. Results showed that, unlike 12-month-olds, 18- and 24-month-olds persevered in copying the model's exact but redundant actions, which for most children resulted in a failure to open the box. Particularly, twelve-month-old subjects only copied the redundant actions of the model when they were given a logical reason to do so; otherwise, they focused on reproducing the outcome of the demonstrated actions.

Evidently, imitation of the intentional action occurs, despite the absence of its goal outcome. The above-mentioned experiment (Nielsen, 2006) implies that the borderline age of such imitative behavior pattern is 18 months, and that 12-month-olds imitate only the effective actions. It is worth noting that such an age pattern



correlates with Vygotsky-Jel'konin's periodization theory according to which an infant is able to engage in a joint object-related activity in the second year of life, just after the so-called one-year-crisis is over (Jel'konin, 1997b).

However, the above-mentioned experiments differ in the level of complexity of the action structure. Additionally, these experiments differ in the relationship between action and result. Thus, Carpenter et al's experiment showed that visible result caused the direct action, while Nielsens procedure represented the actions result, which caused a possibility for the following effective action.

It is possible, that the change of priorities between intention and productivity happens at an earlier age under the condition of a simpler operational structure. The picture of cognitive development can be described as a "nested" structure in relation to the different levels of action complexity. For example, experiments in terms of a child's understanding of goal-directed grasping actions (Woodward, 1998) and gaze direction (Woodward, 2003) involve phenomena of the same type which could be observed sooner or later depending on the level of action complexity. Besides, whereas the structure of the above experiments considered the intention and the result to be equally significant factors, it did not provide for opposition of the action's intentionality to its goal outcome.

Therefore, the present study creates the conditions for a possible choice between two types of actions on the same object: an effective but unintentional one versus an ineffective intentional one. We expect that our results will shed light on the reason for the change of priority in a child's choosing between the intentionality per se and the goal outcome. The results will also reveal whether using a less complex action for the testing procedure would change the age at which the aforementioned switching of priority is observed.

Method

Participants

Group 1: 21 infants aged 12-16 months (mean age 14.2 months), including nine boys and 12 girls.

Group 2: 11 infants aged 17-20 months (mean age 18.1 months), including six boys and five girls.



All participants were recruited from local leisure centers and family clubs within Moscow and the Moscow Region. All of the parents provided informed consent to participate in the study.

Materials

In the experiment we used two objects unfamiliar to the infant. Each of the objects was characterized by details which allowed attractive manipulations by a child with respect to his or her age. For example, there was a transparent ball containing plastic beads inside which could be rotated by pushing, or a plastic butterfly wing which could be turned by holding its edge. Each object had several such details.

Manipulation of one of the details led to the so-called effective event: an easily perceived outcome, attractive for a child of a corresponding age, such as flashing of rolling beads inside the plastic transparent ball or musical ringing sound. Such a manipulation we named an effective action.

Manipulating another detail in each of the objects did not lead to any perceptually attractive event for the child, such as a soundless and colorless turn of the butterfly's wing, when the manipulated detail was moved. Such a manipulation we named a non-effective action.

Procedure

This procedure is the modified version of Carpenter et al's experiment (1998). In the original version of the experiment, all actions of the demonstrator (both intentional and accidental) were effective. Our main modification provides one more contrasting condition in which intentional behavior does not achieve its goal; that is, we include a condition where the adult's intentional action is not effective.

As in Carpenter's experiment (1998), an adult demonstrates to an infant an unfamiliar object with the words "Watch, I'm going to show you how this works. There!" <following a display of the intentional action> "Woops!" <following a display of the action which is produced accidentally>. Then, the experimenter hands over the object to an infant, saying "Your turn!"



Unlike Carpenter et al's experiment (1998), our experiment featured following conditions:

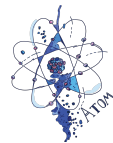
1. Consistent demonstrator behavior: the effective action is carried out intentionally, while the non-effective action is accidental. This condition was a control one, supposing to correspond to what infants usually observe in daily adult behavior. Thus an adult intentionally manipulating an object (saying "There!") resulted in an attractive event, while touching another detail in accidental way (saying "Whoops!") resulted in no noticeable event, besides moving this detail.
2. Non-consistent demonstrator behavior: the effective action is accidental, and the non-effective action is intentional. This is the experimental condition, which disrupts infants' "expectations". This experimental condition is expected to reveal the cues assessed by the infant as reliable in the adult's behavior while transmitting the experience.

The experiment has a within-subjects design; each of the conditions was presented to each of the subjects. The order of conditions, their combinations with the object and the order of the intentional and accidental actions within one condition were counterbalanced.

After the demonstration of actions and saying the words "And now it's your turn!", the experimenter moved an object towards the child and waited for their manipulations on the object. The first manipulation was registered. The whole procedure was videotaped.

We conducted a pre-test playing session with each of the participants in order to establish contact between the experimenter and the child. All participants were accompanied by a parent during the experiment, who was instructed about the terms of the purpose and conditions of the study. In particular, the experimenter instructed the parent not to let the child recognize the correct detail by means of either gaze direction, movement, or any verbal cue.

The expectation was that in the condition of consistent demonstrator behavior, the infant would copy the effective intentional manipulation. We were especially interested in the infants response in the non-consistent condition. If, according to our assumption, children advantageously monitor the intentions of adults when learning new object- related actions, our participants would copy the intentional action of the demonstrator even when this action is ineffective. But if the tendency to follow the adult's intention only plays an auxiliary role and develops from typical



everyday situations when observed intentional actions are also effective, then in the non-consistent condition our participants would copy the accidental action because it is followed by an obvious outcome.

Moreover, we assess the distinction in childrens behavior within different age groups: 12-16 months and 17-20 months.

Results

The dependent variable in our experiment is the first action of the infant, represented by the detail for manipulation on a novel object, just after the demonstration. After an adult says "And now it's your turn!", an infant reaches for the detail, touches it and moves it. The participant may choose either the intentionally touched detail (imitation of an intentional action), or the detail previously used by the experimenter for accidental manipulation (imitation of an accidental action), or the detail which the adult did not touch at all (another action).

Data received for Group 1 are presented in Table 1. The statistical analyses indicates that the first action performed by an infant between 12 and 16 months of age is significantly influenced by the demonstrated adult behavior ($\chi^2=10.13$ $p<0.01$). Thus, given consistent demonstrator behavior, most children copy the intentional action, that is, exhibit the ability to distinguish and to follow the intention. However, non-consistent demonstrator behavior mostly causes the infants to perform "another" action, ignoring both the intentional and the effective action. It appears that the participants in the youngest age group do not prefer to copy the effective action per se: in case of its accidental manner, the infants mainly choose an action which has not been performed by the adult.



Demonstrator behavior style	First object-related action of an infant following actions demonstrated by adult			
	Imitation of an intentional action	Imitation of an accidental action	Another action	Total
Consistent behavior	13	3	5	21
	62 %	14 %	23 %	100 %
Non- consistent behavior	3	6	12	21
	14 %	29 %	57 %	100 %

Table 1. First object-related action of an infant after the demonstration under consistent and non-consistent behavior conditions (for 12 to 16-month-old)

Demonstrator behavior style	First object-related action of an infant following actions demonstrated by adult			
	Imitation of an intentional action	Imitation of an accidental action	Another action	Total
Consistent behavior	9	1	1	11
	82 %	9 %	9 %	100 %
Non- consistent behavior	7	2	2	11
	64 %	18 %	18 %	100 %



At the same time, variations of the consistent adult behavior were not significant in Group 2 ($y^2=0.92$, $p>0.5$): all of the participants persistently imitated only the intentional action regardless of whether the action was effective or not, while absolutely ignoring accidental action even in case of its attractive result in one of the series. Thus, while making the choice for imitation, participants in Group 2 were guided more by an adult's intention than by the action's effectiveness.

The interaction of participant age and congruency of adult behavior was also tested directly. The distribution of children's reactions was significantly different ($y^2=9.03$, $p=0.01$) between the two age groups (12-16 and 17-20 months) which also justifies the selection of age ranges as appropriate for our experiment's design.

Discussion

The obtained results allow us to conclude that starting from the age of 18-months, on the average, infants definitely rely on an adults intentionality while choosing which object- related action to imitate among other observed actions. According to the results, at the average age of 14 months, infants are guided by both the goal outcome and the intentionality of an object-related action. In the condition of non-consistent adult behavior with opposition of intention to the goal outcome, infants avoid such contradiction, performing instead another, not demonstrated action.

As we mentioned above, an infants ability to identify the concrete goal of a grasping motion has already emerged at the age of three to five months (Woodward, 1998; Woodward, Sommerville, & Guajardo, 2001). Beginning at least from 12 months of age infants already prefer the intentional action to the accidental one among two goal-directed actions (Carpenter et al., 1998). Still, our experiment discovered that only at the age of 17 to 20 months are the infants able to ignore the goal outcome of imitation. This means that there is a definite developmental characteristic, evidently preceding the further development of instrumental activity at an early age.

The ability to read an adults intention when selecting a particular action to copy could be a useful strategy within the cultural learning process. Entering the world of typical cultural objects, the infant possess insufficient cognitive abilities for independent selection of goal-directed and effective instrumental actions within the whole picture of observed manipulations.



On the one hand, this may be caused by far too remote adult goals, which, in fact, are often mediated by other events. As an example, while preparing to go for a walk, we put on our coats before exiting a warm space, guided by our awareness of the lower temperature outside. It is too difficult for a one-year-old to imagine "not to feel cold" as a goal in such a situation. On the other hand, it is obvious that an infant is able to achieve most of the current goals by ignoring any existing corresponding artifacts. For example, for a two-year-old infant it is a much more reliable method to tear off a piece of paper than to cut it off with scissors. Moreover, the relation between the manipulation per se and its result is too complicated, often regulated by objective laws, which are hardly understandable even for an adult: why from pressing the button the lamp lights up can hardly be thoroughly explained by someone who is not a physicist.

All the facts mentioned above would make early object-related action learning too slow and hardly accessible if an infant is guided primarily by the outcome of goal-directed adult behavior. That is, the early ability to follow an adults intentions, described in many studies (Meltzoff, 1988; Carpenter et al., 1998; Carpenter, Call, & Tomasello, 2002; Gergely & Csibra, 2003) is quite essential and functional. Indeed, the adults intent is well noticeable by its preparation, its nature, reaction to the events following it; the rule "to copy everything that is intentional" would be rather convenient during the acquisition of experience at learning how to manipulate objects.

Our data show the need for a more complicated model, describing the selective mechanism within the imitation process. Thus, our results show that the above rule does not always guide the infant. That is, at the earliest stages of childhood both the goal outcome and the adults intention influence an infants imitating behavior, but while growing up, infants focus on the adult's intentionality within a selective imitating process. How is it turn that, while growing older, the child seems to follow a less "objective" guidance? Previous research has proven the infants ability to understand adults' intentions which we suggest could be explained by the infants ability to read the adults reaction at the end result and, thereby, detecting the fact of action intentionality. For example, within Meltzoff s experiment (1995), the adult "was trying" to put some beads on a thread into a narrow glass cylinder but as a result, the thread kept hanging from the sides of the cylinder which seemed to disappoint the experimenter who consequently reacted with a sad voice, gaze, and an exclamation of "Whoops!" just after the action. It is



remarkable that such a reaction may assist an infant in understanding the exact adult intention of this action.

Indeed, most research on intentional relations shows co-variation between the adult intent and the end result (Meltzoff, 1988; Carpenter et al., 1998; Carpenter, Call, & Tomasello, 2002; Gergely & Csibra, 2003), and, hence, the child's preference to imitate the intentional action is explained rather by the infant's identification of the adult's reaction at the goal outcome, but not by an infant's general ability to understand the intentions. Recent studies of Kiraly, Csibra and Gergely (2013) showed the corresponding results of the experiment wherein 14-month-old infants did not copy the adult's action in the absence of the goal outcome, although the action was performed intentionally and, moreover, it was supported by ostensive communicative cues.

Such a focus tends to interpret the behavior of the eldest group in our research not as simpler and less "objective" but as highly organized. Evidently, an 18-months old child determines action intentionality not by reading the adult's reaction to the external event, but rather by means of detected preparation of the action and action properties. To our opinion, such markers are closer related to the internal perception of the intention, contributing to joint attention engagement and to preserving the shared experience (Tomasello, Carpenter, Call, Behne, & Moll, 2005).

Moreover, such a strategy provides the infant with an understanding of the remote goal-directed actions described above. This explanation can also be applied to the above-mentioned overimitation effect. We suppose that the current results contribute to the research on both intentionality and overimitation effect, showing the close relation between these fields. Research of the first mentioned field was mainly directed towards assessing a child's ability to detect the intentions of others (Woodward, 1998; Woodward et al., 2003; Carpenter et al., 1998; Gergely & Csibra, 2003), however, the procedure usually included a test situation with a child reproducing the adults' actions. The second research direction mentioned above was mainly dedicated to discovering the reasons for the overimitation effect in child behavior (Whiten, Custance, Gomez, Texidor, & Bard, 1996; Call, Carpenter, & Tomasello, 2005; Lyons, Young, & Keil, 2007; Keupp, Behne, & Rakoczy, 2013; Király, Csibra, & Gergely, 2013), considering intentionality as influential factor in this phenomenon.

In our opinion, this situation indicates the relation of the two problems and calls for the creation of a common model explaining



the development of intentional relations being the meaningful factor within the structure of social learning. Our data show that such a model has to include both stages: when social learning is formed by an understanding of intent depending on the adult reaction which follows the goal outcome, and when social learning is based upon the properties of the adult action per se. However, an 'independence' from the outcome at the latter stage does not imply that children recklessly copy every adults intentional action; they use cues of competent adult behavior. For example, preschoolers do not imitate adults' actions that are intentional but displayed in an unconfident manner, as if performed for the first time (Kotova & Preobrazhenskaya, 2009).

One of the purposes of the current paper was to compare results obtained in M. Nielsen's study (2006) and ours. His work discovered similar results in terms of the age limits for a child's tendency to follow the intentionality of the adult regardless of the goal outcome. The procedure was arranged in a usual manner within the overimitation research paradigm: an ineffective action was operationalized as irrelevant for the goal outcome (such an action was redundant for obtaining the goal), and the goal outcome did not follow the adult action automatically but the adult action opened a way to achieve the goal outcome at the next step (e.g., retrieving a toy).

Evidently, compared to Nielsen's study (2006), our results would have to exhibit an earlier age limit due to the lower complexity level of the action structure in the described design. As a reminder, we state that a preference for intentionality over effectiveness in childrens imitation is a manifestation of the emerging ability to identify intentions of the adult using not only the adult's reaction to the end result, but also cues that precede or accompany the action. In terms of our reasoning, the procedure of Nielsen's experiment met the similar requirements for testing an infant's ability to attribute adult intention. Therefore, it was quite expected that our study revealed the similar age limitation despite the differences in the complexity levels.

Such converging evidence allowed us to make one more important conclusion for the research fields of both overimitation and social learning. If we discuss social learning as learning how to perform certain actions from adult behavior, then according to the traditional view we should expect that acquired actions become more and more complex with age. But our results suggest that what changes with development is that the actions acquired by the child become more



and more relevant to planning and control of behavior. That is, the older the child becomes, the more they are ready to adopt the way that adults select their actions and control for performance. Indirectly, it provides for a child is acquiring more complex actions. However, complexity is not a key factor, but rather a by-product of the development of social learning. We argue that the organization, selection and planning components of the acquired action, which cause the increased complexity of instrumental activity, is the real achievement in social learning development.

As a whole, our study, arranged in a novel way to contrast two conditions pertaining to the intention and goal outcome in adult behavior, has shown that 17 to 20-month-old children prefer to imitate an adult's intentional action rather than an accidental one, regardless of the obtained end results. Moreover, we found that in the experimental condition 12 to 16-month-old infants select some other action but none of the two actions demonstrated by adult. While comparing our results to other research (including the overimitation effect studies), we have reached the conclusion, that the revealed priority of intentional actions in children's imitation under the condition of non-consistent adult behavior is caused by the adult's action preparation and properties, which guide an infant in determining adult's intentional behavior.

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