

Infants' imitative learning from third-party observations

The role of the second adult

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In two separate experiments, we examined 17-month-olds' imitation in a third-party context. The aim was to explore how seeing another person responding to a model's novel action influenced infant imitation. The infants watched while a reliable model demonstrated a novel action with a familiar (Experiment 1) or an unfamiliar (Experiment 2) object to a second actor. The second actor either imitated or did not imitate the novel action of the model. Fewer infants imitated the model's novel behavior in the non-imitation condition than in the imitation condition in Experiment 1. In Experiment 2, infants' likelihood of imitating was not influenced by whether they had watched the second actor imitating the model's novel action with the unfamiliar object. The findings indicate that infants take into account a second adult's actions in a third party context when infants receive information that contradicts their existing knowledge and when it corresponds with their own experiences. If infants do not have prior knowledge about how to handle a certain object, then the second adult's actions do not seem to matter.

Keywords: infants, imitation, third-party context, reliable model

For a growing child, there are limitless things to learn about the world and a multitude of ways of gaining such knowledge. For instance, a child who has developed language can ask questions about things that they may encounter, such as how to open an interesting box. Infants and children can also learn through trial-and-error. When infants and children are exploring objects using trial-and-error, they may learn about objects' properties and learn from the consequences of their own actions. However, such methods can sometimes be risky for the child, time-consuming, and are not always effective (Bekkering, Wohlschlager, & Gattis, 2000; Meltzoff, 1999).

Another way of learning is through copying the behaviors of others (e.g., Barr & Hayne, 2003; Brosseau-Liard & Poulin-Dubois, 2014; Ray & Heyes, 2011). By imitating others' behaviors, young children learn new words (e.g., Floor & Akhtar, 2006), skills, and behaviors (e.g., Moraru, Gomez, & McGuigan, 2016; Yang, Sidman, & Bushnell, 2010). Furthermore, imitation helps infants build social relationships with other people (Chartrand & Bargh, 1999). Hence, imitation is one important form of social learning that allows the faithful transmission of information between individuals (e.g., Csibra & Gergely, 2006; Nielsen, 2006). In most cases, infants and young children have at least one adult in close proximity who can serve as a model for new actions and behaviors. However, infants do not imitate just any adult. By 14 months, infants are selective in whom they prefer to imitate (e.g., Poulin-Dubois, Brooker, & Polonia, 2011). For example, when an adult had previously demonstrated an object incorrectly (e.g., putting sunglasses on his foot instead of on his nose, i.e., the unreliable adult), infants were reluctant to imitate the adult's subsequent novel actions with an object (Zmyj, Buttelmann, Carpenter, & Daum, 2010). In contrast, when the adult had demonstrated an object correctly (e.g., putting a shoe on his foot and not on his hand, i.e., the reliable adult), infants were more willing to imitate the adult's novel action. Hence, infants prefer to imitate a reliable adult than an adult who has proven by previous actions to be unreliable.

A question of interest is whether or not the familiarity of an object influences infants' and children's willingness to imitate a certain action on that object. For example, infants and children may learn a new action on an object which is already familiar to them and which they have prior knowledge about how to use (one and the same object may sometimes have a wide range of uses). Previous studies have not focused specifically on that question. However, children may learn a new label for a familiar object from an adult who previously has proven to be reliable, although the new label contradicts their current knowledge. In a study by Krogh-Jespersen and Echols (2012), an adult (a speaker) showed varying levels of knowledge concerning the names of objects. When the adult had labeled familiar objects correctly (the reliable speaker), the 2-year-olds were more willing to learn a second label for a familiar object than when the adult had labeled the familiar objects inaccurately or had displayed ignorance (the unreliable speaker). Whether infants and children will learn a new action on a familiar object and thus disregard their own knowledge concerning how to use the object is a question that remains to be answered.

There is often more than just one adult present in close proximity to an infant. These adults might also be engaged in some kind of joint action that does not directly address the infant. For example, an infant observes two parents putting up curtains in the living room, or watch while several teachers prepare the lunch

table. Many times throughout a typical day, infants are exposed to adults who are interacting with each other and with objects. Consequently, infants may learn new skills and behaviors by observing other peoples' interactions, even without the infant directly taking part in the interaction. Learning from others in such contexts can be regarded as "third-party observation" (e.g., Matheson, Moore, & Akhtar, 2013). Findings from studies examining third-party contexts show that when infants and young children observe an adult demonstrating actions to another adult, children may copy those actions, even though the child was not the intended addressee (e.g., Matheson et al., 2013; Nielsen, Moore, & Mohamedally, 2012; Shimpi, Akhtar, & Moore, 2013; Shneidman, Todd, & Woodward, 2014). For example, after observing an adult demonstrating causally non-obvious actions with different objects (children's toys) to another adult, 2-year-olds imitated the model's actions regardless of whether the actions were directed at the child or at the other adult (Shneidman et al., 2014). However, the Shneidman et al study does not tell us whether or not these toys were familiar or not to the children.

Repacholi and Meltzoff (2007) examined what 18-month-old infants may learn from third-party contexts. In their study, the infants observed an experimenter who was performing actions with objects. The test objects consisted of three novel objects (replicas of objects constructed for a previous study, Meltzoff, 1988). The infants then watched while the experimenter demonstrated an action with an object to a second adult, during which the second adult expressed a neutral or angry affect toward the experimenter. After the infants had seen the second adult expressing anger, the infants were less willing to interact with the object. These findings indicate that in a third-party context, the emotional reactions of an adult during an interaction may influence infants' likelihood to imitate the action.

In another study, 17-month-old infants' imitation in a third-party context was examined across four experiments (Stenberg, 2020). In the first phase of each experiment, the adult model demonstrated her reliability (or unreliability) by acting correctly (or incorrectly) with different familiar objects. Afterwards, the model then demonstrated a novel action with a familiar or unfamiliar object to another adult (the model's "friend"). The infants were not involved in any direct interaction with any of the two adults during the demonstration of the objects. The infants were more willing to imitate the reliable model's action with the unfamiliar object than the unreliable model's action, indicating that the infants took into account the reliability of the model. Whether or not the infants saw the model's friend imitating the model's novel action did not influence infants' willingness to imitate.

In these four experiments (Stenberg, 2020), the second adult always acted like a novice learner (e.g., asking the model what to do with the different objects during the demonstrations) and the model acted as a knowledgeable teacher (e.g.,

telling and showing the second actor how to use the objects). When the second adult got the opportunity to imitate (in two of the four experiments), she never questioned or objected to performing the novel action. Instead, she just copied the model's behavior and then handed the object back to the model. These experiments therefore do not provide information regarding whether infants' likelihood to imitate would have been influenced by the second adult questioning the performance of the model, or whether the characteristics of the target objects (familiar/unfamiliar) then would have had an influence.

In summary, in everyday situations infants see people acting together on objects, exchanging opinions and views about what to think about different objects and how to use them. Results from previous imitation studies show that infants take into account adults' previous behavior when choosing whom to imitate (e.g., Zmyj et al., 2010). Infants prefer to imitate a reliable adult rather than an adult who has proven to be unreliable (Brooker & Poulin-Dubois, 2013) and children may even learn new names for familiar objects from a reliable adult and thus disregard their own knowledge (Krogh-Jespersen & Echols, 2012).

In third-party contexts, infants also take into account the reliability of an adult model although the model has not directly demonstrated her reliability to the infants but to another person while the infants were watching (e.g., Matheson et al., 2013). Further, there are also findings indicating that a second adult's responses to the model's actions in a third-party context influence infants' tendency to imitate the model (Repacholi & Meltzoff, 2007). Thus, infants also learn from observing other people interacting although the infant is not directly engaged.

The current experiments

The aim of the current research was to study whether an adult's response to the performance of another adult's action influences whether infants are likely to imitate the action or not. Infant imitation was examined in a third-party context in two separate experiments. In both experiments a reliable adult model demonstrated a novel action with an object to another adult. In one condition, the second adult imitated the model's action (the imitation condition), while in the other condition she was not willing to imitate the target action (the non-imitation condition). In both experiments, infant imitation was examined during the last phase.

We also examined whether the infants' prior experience or a lack of experience with objects would influence infants' proneness to imitate the model's unusual behavior. In Experiment 1, the target object was familiar to the infants (a children's spoon), meaning that the infants had prior knowledge about how to

use the object. In Experiment 2, the target object was unfamiliar (a USB memory stick) and the infants had no prior knowledge of how to handle the object.

Experiment 1

In Experiment 1, 17-month-old infants were watching two adults who were interacting. One of the actors (the model) began the interaction by demonstrating how to use three different familiar objects to the second actor. By that she showed that she was able to handle the objects correctly and thus was a reliable person. To mirror what transpires during everyday interactions between adults, the adults were talking to each other during the demonstrations. The model concluded the demonstrations by performing a novel action with a fourth familiar object (holding the target object, the children's spoon, at her forehead). This is an unusual action which the infants should not connect with the usage of the spoon. The children's spoon has been used in previous studies of infant imitation (Stenberg, 2019, 2020) and meets the criteria of being familiar to most infants and being an object most infants have daily experience with and know how to use.

In one condition the second actor imitated the novel action and in the other condition the second actor questioned the action and thus did not imitate. We thereafter examined the infants' tendency to imitate the unusual action with the children's spoon. We wanted to explore whether the infants would take into account the second actor's responses concerning the performance of the model's novel action when deciding whether or not to imitate.

Repacholi and Meltzoff (2007) found that the 18-month-olds in their study were less willing to interact with a novel object after watching another adult expressing anger toward the experimenter who demonstrated the target action on the object. In the present study, the second actor in the non-imitation condition did not express anger. However, she expressed doubt concerning what to do with the object and was not willing to imitate. Watching the second actor refraining from imitating the model's novel action may influence infants' willingness to imitate the action. Furthermore, the infants in the present experiment had prior knowledge about how to use the object (the children's spoon). Accordingly, we predicted fewer infants to imitate in the non-imitation condition than in the imitation condition.

Method

Participants

Forty-two full-term 17-month-old infants ($M=17.11$ months, $SD=2.3$ weeks; 20 girls, 22 boys) were included in the final sample. Nine infants were excluded due to experimental errors ($n=4$) or infant fussiness ($n=5$). No a priori sample size calculation was carried out. Fifty-three percent of the infants had between 1 and 4 siblings ($M=1$ sibling). All participants were recruited from birth records in a greater metropolitan area in Sweden. Infants were primarily from white and middle-class backgrounds.

The age of the accompanying parent ranged from 21 to 49 years (mothers, $M=27.7$ years, $SD=6.8$ years; fathers, $M=32.4$ years, $SD=6.9$ years). The education level of the accompanying parent included: university degree (33% mothers, 30% fathers), started or completed other post-high school training (36% mothers, 47% fathers), and completed high school (31% mother, 23% fathers). The parents received a gift certificate with a value of approximately 10 Euros. The study was conducted in compliance with the ethical standards specified in the 1964 Declaration of Helsinki.

Experimental conditions

Half of the sample was allocated to the imitation condition (10 girls, 11 boys) and the other half to the non-imitation condition (10 girls, 11 boys). Each condition consisted of a demonstration phase, imitation phase, and test phase.

Demonstration phase: The model demonstrated three familiar objects and then demonstrated a novel action with a fourth familiar object (the target object) to the second actor. The model then handed the target object to the second actor.

Imitation phase: The second actor either imitated or refrained from imitating (depending on condition) the model's novel action with the target object and then gave the object back to the model.

Test phase: The model handed the target object over to the infant who could do whatever they wanted with the object during a two minute period.

Set-up and materials

Two female experimenters conducted the study. The study was performed in a laboratory playroom (3.5 m $\times$ 4 m) equipped with a table, chairs, an infant high-chair, two video cameras, and a box. The box was placed beneath the table, out of sight of the infants, and contained two magazines and the four objects that were used during the session: a shoe, a mitten, a baby sipper, a children's spoon (the target object). The two adults were sitting face-to-face at one long side of the table

and the infant was seated across the table opposite to the adults. The adults' chairs were positioned approximately 50 cm from the edge of the table so the infants could easily view the model acting with the different objects. One camera was placed behind the two adults' chairs, capturing the infant's behavior, and the second camera was placed behind the infant's highchair, capturing the two adults. The infant's parent was sitting slightly behind the infant during the entire session. All three phases in each condition were video recorded for later coding.

Procedure

An experimenter (the model) instructed the parent about the experimental procedure and obtained informed consent. Meanwhile the second actor was sitting at the table reading a magazine. Following consent, the parent was told to put the infant in the highchair and then sit down at one of the chairs, slightly behind the infant. The parent was instructed to hold a magazine in front of them and pretend to read. The parent was also instructed to refrain from prompting the infant in any way but to remain supportive if the infant turned toward them. The model sat down at the table, nearby the second actor, and began the demonstration by saying to the infant in a friendly voice, "Now I will show some objects to my friend". The model took an object out from the box under the table and then turned to the second actor while saying, "Look, here I have (e.g., a mitten)!". The second actor responded, "Yes, you have (e.g., a mitten)". The model continued by saying, "You put the mitten on your hand". The second actor responded, "Yes, you put the mitten on your hand". The model put the mitten on her hand and after a couple of seconds, put the mitten back into the box and retrieved another object. The model held the baby sipper at her mouth and put the shoe on her foot while talking to the second actor. All three objects were demonstrated once in a randomized order. Neither of the two adults spoke to or looked toward the infant during object demonstration. Consequently, the adults provided ostensive cues but only toward each other and not to the infant. After putting the third object back into the box the model brought out a fourth object (the children's spoon) while saying, "Here is something else!", "You put it on your head". In the imitation condition, the second actor responded, "Yes, you put it on your head". In the non-imitation condition, the second actor responded, "No, you don't put it on your head". The model held the children's spoon at her forehead for a couple of seconds and then said to the second actor, "Did you see what I did? I put it on my head. I will show you once again". The model then repeated the demonstration. After demonstrating the novel action with the children's spoon a second time, the model gave the children's spoon to the second actor while saying, "Now you can borrow it".

In the imitation condition, after receiving the children's spoon, the second actor said again, "Yes, you put it on your head", and imitated the model's action

once (holding the children's spoon at her forehead). The second actor then gave the children's spoon back to the model. In the non-imitation condition, after receiving the children's spoon, the second actor again said, "No, you don't put it on your head", and gave the children's spoon back to the model, without imitating the action.

The model, in both conditions, then gave the children's spoon to the infant while saying, "Now you can borrow it". Thereafter the model took two magazines from the box, gave one of the magazines to the second actor and kept one for herself. Both the model and the second actor pretended to read the magazines. After the infant first touched the children's spoon, the infant was given two minutes to imitate the novel action. After these two minutes, the test phase ended.

The actions that the model demonstrated with the different objects deserve some clarification. The actions that the model performed in both the imitation and the non-imitation conditions with the first three objects (the mitten, the baby sipper, the shoe) were all familiar actions, i.e., actions that the infants would connect to the three objects respectively. The action that the model performed with the target object (the children's spoon) on the other hand, was an unfamiliar action (just holding the target object at the forehead). The rationale behind choosing that action was to demonstrate an action that the infants would not connect to the usage of the familiar target object, the children's spoon (you put a spoon into your mouth). Furthermore, we also wanted to demonstrate an action that was easy for the infants to imitate.

Coding and reliability

A coder who was blind to the research questions coded the behaviors of the two adults and the infants' behaviors during the demonstration phase and the imitation phase. Another blind coder coded the infants' behaviors during the test phase. A third coder independently coded 50% of the videotapes to establish reliability. There were no significant mean differences between the coding by the reliability coder and the coding of the other two coders. Agreement was assessed by calculating intraclass correlations (ICC) for frequencies. Cohen's kappa was calculated for categorical variables.

Manipulation checks

Both of the adults' behaviors were coded from the videotapes to ensure that they followed the experimental protocol. We checked whether the model demonstrated the four objects in accordance with the experimental protocol (e.g., put the mitten on the hand, $Kappa=1.0$). The model demonstrated all four objects according to the experimental protocol in both conditions. We also registered the number of times the model demonstrated each object: the shoe, the mitten, and

the baby sipper were each demonstrated once ($ICC=.98$), the children's spoon (the target object) was demonstrated twice in both conditions ($ICC=1.0$).

We assessed whether the second actor followed the experimental protocol in both conditions: holding the children's spoon at her forehead once in the imitation condition ($Kappa=1.0$) and refraining from imitating the action in the non-imitation condition ($Kappa=1.0$). The second actor always performed the novel action once in the imitation condition and never in the non-imitation condition. We checked whether the second actor verbally disagreed with the model on how to use the children's spoon in the non-imitation condition ($Kappa=1.0$) and verbally agreed with the model on how to use the children's spoon in the imitation condition ($Kappa=1.0$). The second actor always disagreed with the model in the non-imitation condition and always agreed with the model on how to use the children's spoon in the imitation condition. Because the second actor displayed different behaviors in the two conditions (imitating in the imitation condition and refraining from imitating in the non-imitation condition), we coded for the length of time that the imitation phase lasted in the imitation condition ($ICC=.89$) and the non-imitation condition ($ICC=.87$). The duration of the imitating phase ranged from 7 sec to 10 sec. There was no difference in duration between the two conditions, $t(40)=0.96$, $p=.301$ (imitation condition, $M=8.01$ sec, $SD=1.50$ sec; non-imitation condition, $M=7.67$ sec, $SD=1.39$ sec). We found that the infants in both conditions were exposed to the second actor copying or not copying the model's novel action for the same amount of time during the imitation phase.

We registered the model's looking behavior ($ICC=.87$) as well as the second actor's looking behavior ($ICC=.90$) during the demonstrations. The model was looking at the objects she was demonstrating and looking at the second actor 96% of the time. The second actor was most of the time looking at the model (98% of the time).

We also coded the number of 5-sec intervals during which the two adults exhibited positive, neutral, and negative facial expressions during the demonstration and the imitation phases in both conditions. In the imitation condition, the model expressed positive affect for a mean of 81% of the time and neutral 19% of the time. In the non-imitation condition, the model expressed positive affect for a mean of 85% of the time and neutral 15% of the time. For the second actor, during the imitation condition she expressed positive affect for 83% of the time and neutral 17% of the time. In the non-imitation condition, she expressed positive affect for a mean of 79% of the time and neutral 21% of the time. Neither of the adults displayed negative facial expressions during any of the experimental phases. Intraclass correlations ranged from .89 to 1.0 for positive, neutral, and negative facial expressions.

Measures of infant variables

Demonstration phase

We calculated the percentage of time the infants spent looking at the scenario ($ICC=.89$). The infants had to be looking at the scenario for at least 75% of the time to be included in the final sample. We found that all infants looked for more than 75% of the time in both conditions and we found no difference in infant looking between the two conditions, $t(40)=1.29$, $p=.231$.

Test phase

We coded whether the infants imitated the model's action with the children's spoon. Imitating the action was defined as holding the children's spoon at the forehead, on top of the head, or holding the children's spoon above the nose ($Kappa=.91$).

Results

We used the statistical program SAS Version 9.4 (Statistical Analysis Software) to analyze the data. We performed Chi-squared test (χ^2 test) to examine the number of infants who imitated the target action in both conditions. The variables that were included in the analyses were "Imitating the target action" (holding the children's spoon at the forehead, on top of the head, or above the nose) and "Not imitating the target action" (not holding the children's spoon at the forehead, on top of the head, or above the nose).

There were fewer infants who imitated the model's novel action with the children's spoon in the non-imitation condition compared to the imitation condition, $\chi^2(1, 42)=4.20$, $p=.040$, $w=.32$. Nine out of 21 infants (43%) imitated the model's action in the imitation condition. Three of the 21 infants (14%) imitated the unusual action in the non-imitation condition.

There were several infants in both conditions that did not imitate the action. These infants were banging the spoon toward the surface (the table), shaking or waving the spoon, manipulating the spoon on the table, or lifting the spoon to the mouth.

Discussion

In Experiment 1, the object that the model was demonstrating to the second actor was familiar to the infants (a children's spoon). Therefore, the infants had prior knowledge about how to interact with the object. Fewer infants imitated the model's novel action with the target object in the non-imitation condition com-

pared to the imitation condition. Watching the second actor in the non-imitation condition refraining from performing the novel action with the spoon was consistent with the infants' own experiences and may thus have strengthened the infants' decision not to imitate the action.

Less than half of the infants in the imitation condition imitated the novel action. Watching the second actor in the imitation condition imitate the model may have influenced these infants' proneness to also imitate the action. However, there were few infants who imitated in both conditions in Experiment 1. Because the infants knew what to do with the children's spoon, the infants in Experiment 1 may have regarded the model's demonstration of the spoon as a silly action which reduced the infants' willingness to imitate the action regardless of the second adult's responses. To further examine whether the second adult's reaction to the model's action influences infants' proneness to imitate the action, a second study was conducted (Experiment 2). In Experiment 2, the model performed a novel action with an object that was unfamiliar to the infants.

Experiment 2

Experiment 2 contained two conditions: the imitation condition and the non-imitation condition. The design and procedure were similar to Experiment 1, except that the target object that the model demonstrated to the second actor was unfamiliar to the infants (a USB memory stick). A USB memory stick has been used in previous infant imitation studies (Stenberg, 2019, 2020). The object is similar in size and weight to the children's spoon and easy for an infant to hold. However, in contrast to the children's spoon, the USB memory stick is an object that infants do not have experience with. Thus, the infants had no background knowledge about how to use the object.

In the imitation condition, the infants watched the second actor imitate the model's action on the unfamiliar object, while in the non-imitation condition the infants observed the second actor refraining from performing the action. If the second adult's reaction to the model's action influences infants' willingness to imitate the model, then fewer infants should imitate in the non-imitation than in the imitation condition.

Method

Participants

Forty-two full-term 17-month-old infants ($M=17.05$ months, $SD=1.9$ weeks; 23 girls, 19 boys) participated in the study. Data from another seven infants were not included in the final sample due to experimental errors ($n=2$) or infant fussiness ($n=5$). No a priori sample size calculation was carried out. Fifty percent of the infants had 1 to 4 siblings ($M=1$ sibling). All participants were recruited from birth records in a greater metropolitan area in Sweden. Infants were primarily from white and middle-class backgrounds.

The age of the accompanying parent ranged from 18 to 50 years (mothers, $M=30.1$ years, $SD=8.7$ years; fathers, $M=32.3$ years, $SD=9.4$ years). The education level of the accompanying parent included: university degree (37% mothers, 36% fathers), started or completed other post-high school training (35% mothers, 37% fathers), and completed high school (28% mother, 27% fathers). All parents received a gift certificate with the value of approximately 10 Euros. The study was conducted in compliance with the ethical standards specified in the 1964 Declaration of Helsinki.

Experimental conditions

The infants were randomly assigned to either the imitation condition (10 girls, 11 boys) or the non-imitation condition (13 girls, 8 boys).

The *demonstration phase*, the *imitation phase*, and the *test phase* were identical to Experiment 1 except that the target object (a USB memory stick) was unfamiliar to the infants.

Set-up and materials

The set-up and materials were the same as in Experiment 1, with the exception of the target object.

Procedure

The procedure was the same as in Experiment 1. (See Experiment 1 for a description.) Before the experimental procedure began, the parent was shown the USB memory stick and asked whether the infant was familiar with the object. None of the infants were familiar with the object.

Coding and reliability

The coding procedure was identical to Experiment 1. We found no significant mean differences between the coding by the reliability coder and the coding by the other two coders.

Manipulation checks

We conducted an extensive manipulation check to control for possible experimenter effects (see Experiment 1 for a detailed description of the different variables). In both conditions, the model demonstrated all four objects according to the experimental protocol ($Kappa=1.0$). The shoe, the mitten, and the baby sipper were demonstrated once ($ICC=.97$). The target object (the USB memory stick) was demonstrated twice ($ICC=1.0$). The second actor performed the unusual action once in the imitation condition ($Kappa=1.0$). She never imitated the action in the non-imitation condition ($Kappa=1.0$). Furthermore, she always verbally agreed with the model on how to use the USB memory stick in the imitation condition ($Kappa=1.0$) and always verbally disagreed with the model concerning the usage of the USB memory stick in the non-imitation condition ($Kappa=1.0$). We also coded for the length of time that the imitation phase lasted in the imitation condition ($ICC=.85$) and the non-imitation condition ($ICC=.85$). The duration of the imitating phase ranged from 7 sec to 10 sec. There was no difference in duration between the two conditions, $t(40)=1.53$, $p=.191$ (imitation condition, $M=8.88$ sec, $SD=1.08$ sec; non-imitation condition, $M=7.93$ sec, $SD=1.32$ sec). During the demonstrations, the model was mostly looking at the objects she was demonstrating and looking at the second actor (97% of the time, $ICC=.89$). The second actor was looking at the model 97% of the time ($ICC=.87$).

In the imitation condition, the model expressed positive affect for a mean of 84% of the time and neutral 16% of the time. In the non-imitation condition, the model expressed positive affect for a mean of 80% of the time and neutral 20% of the time. For the second actor, during the imitation condition, she expressed positive affect for 81% of the time and neutral 19% of the time. In the non-imitation condition, the second actor expressed positive affect for a mean of 78% of the time and neutral 22% of the time. Neither the model nor the second actor displayed negative facial expressions in any of the two conditions. Intraclass correlations ranged from .87 to 1.0 for positive, neutral, and negative facial expressions.

Measures of infant variables

See Experiment 1 for a description of the variables.

Demonstration phase

The infants in both conditions looked for more than 75% of the time at the scenario ($ICC=.90$). We found no difference in infant looking between the imitation and the non-imitation conditions, $t(40)=1.12$, $p=.276$.

Test phase

We registered whether or not the infants imitated the model's novel action on the USB memory stick ($Kappa = .93$).

Results

The analyses were conducted with SAS 9.4. The number of infants in each condition that imitated/did not imitate was calculated using the Chi-squared test (χ^2 test). The variables that were included in the analysis were "Imitating the target action" (holding the USB memory stick at the forehead, on top of the head, or above the nose) and "Not imitating the target action" (not holding the USB memory stick at the forehead, on top of the head, or above the nose).

There was no difference in the number of infants who imitated between the two conditions, $\chi^2(1, 42) = 2.38$, $p = .123$, $w = .24$. Thirteen of the 21 infants (62%) imitated the model's novel action with the USB memory stick in the imitation condition, whereas 8 out of 21 infants (38%) imitated in the non-imitation condition.

Also in Experiment 2, the infants who did not imitate the action were holding the USB memory stick while banging the object toward the surface (the table), shaking or waving the object, or manipulating the USB memory stick on the table.

Discussion

In contrast to Experiment 1, the model in this second experiment performed a novel action with an object which was unfamiliar to the infants (a USB memory stick). There was no difference between groups in the number of infants who imitated. In Experiment 2, when the object was unfamiliar, the imitation behavior of the second actor did not seem to have influenced infants' imitation.

Experiment 1 vs. Experiment 2

We examined whether the infants' prior knowledge or a lack of knowledge about how to handle a certain object would influence infants' imitation. Thus, in order to examine infant imitation when the target object was familiar versus unfamiliar to the infants, we compared the results from the imitation condition in Experiment 1 (familiar object) to the results from the corresponding condition in Experiment 2 (unfamiliar object). All analyses were conducted with SAS 9.4. The number of infants in each condition in Experiments 1 and 2 that imitated/did not imitate was calculated using the Chi-squared test (χ^2 test). The variables that were

included in the analysis were “Imitating the target action” (holding the children’s spoon at the forehead, on top of the head, or above the nose) and “Not imitating the target action” (not holding the children’s spoon at the forehead, on top of the head, or above the nose). The number of infants who imitated/did not imitate in each condition is presented in Table 1.

There was no difference between conditions in the number of infants who imitated, $\chi^2(1, 42) = 1.53, p = .217, w = .19$. When both the model and the second actor performed the novel action, no difference in imitation was found between conditions. Hence, whether the object was familiar or unfamiliar to the infants did not influence infant imitation when both adults performed the action.

Furthermore, we compared the results from the non-imitation condition in Experiment 1 (familiar object) to the results from the non-imitation condition in Experiment 2 (unfamiliar object). There was no statistically significant difference between conditions, $\chi^2(1, 42) = 3.08, p = .079, w = .27$. Given the small sample size, the results must be interpreted with caution.

Table 1. Number of infants by condition who imitated/did not imitate during the test phase

	Condition	
	Imitation condition	Non-imitation condition
<i>Experiment</i>		
<i>Experiment 1</i>	<i>n</i> = 21	<i>n</i> = 21
Imitate	9 (43%)	3 (14%)
Not imitate	12 (57%)	18 (86%)
<i>Experiment 2</i>	<i>n</i> = 21	<i>n</i> = 21
Imitate	13 (62%)	8 (38%)
Not imitate	8 (38%)	13 (62%)

General discussion

Across two experiments, we explored whether infant imitation was influenced by seeing how another adult responded to a model’s unusual behavior. We also considered whether the infants’ existing knowledge or lack of knowledge about how to use the two objects (the children’s spoon, the USB memory stick) would influence the infants’ proneness to imitate the novel action. As predicted, in Experiment 1, we found that more infants were willing to imitate the model’s novel behavior when another adult had first also imitated the model. It seems that the

infants in Experiment 1 had taken into account the behavior displayed by the second actor and used that information in guiding their own actions with the target object.

There are other possible explanations as to why fewer infants were willing to imitate in the non-imitation condition than in the imitation condition in Experiment 1. Infants might be more prone to follow the instructions provided by an adult who is attending to them than an adult who is attending elsewhere. It could be that where the second actor directed her attention during the imitation phase may have influenced the infants' willingness to imitate. If the second actor was looking at the infants during the imitation phase in the non-imitation condition, the infants may have regarded her behavior (to refrain from imitating) as a signal intended for the infants. The infants may have experienced that they were the addressee of the second actor's communication and consequently interpreted the model's novel action as wrong and something that the infants should not imitate. If the second actor attended to the infants in the imitation condition, the infants may have interpreted her behavior as an encouragement to imitate. However, when we checked whether the second actor implemented the experimental protocol we found that she never looked at the infant while she was questioning the model's novel action in the non-imitation condition. Nor did she look at the infants when she was imitating the model in the imitation condition. In both conditions, the second actor was just looking at and talking to the model. She never tried to elicit the infants' attention in any of the two conditions. Thus, differences in attention received from the second actor during the imitation phase do not seem to explain the difference in infant imitation between the two conditions in Experiment 1.

The present research has some limitations that need to be discussed. Foremost, the sample size is low, both in Experiment 1 and in Experiment 2; there were 42 infants in each experiment (21 infants in each condition in Experiment 1 and Experiment 2). Therefore, the results should be treated with caution until they have been replicated.

The number of times the unusual action was demonstrated may have influenced infants' proneness to imitate. The infants in the imitation condition in both Experiments 1 and 2 did not merely see the model performing an unusual action on the target object. These infants also watched while the second actor performed the action. The infants in the imitation conditions were exposed to one more demonstration of the novel action (two by the model, one by the second actor) than the infants in the non-imitation conditions. Hence, we cannot rule out that the difference between conditions in the number of demonstrations of the unusual action may have influenced the results.

During the demonstrations, the adults provided ostensive cues, but only toward each other and not to the infant. However, at the very beginning of the experimental session, the model began by saying to the infant, “Now I will show some objects to my friend”. Although the model then turned to the second actor and did not look nor speak to the infant during the demonstration, the infants were actually addressed once. Such addressing of the infant may serve as an invitation to pay attention and that something interesting might happen. A similar study of infants’ learning from third-party observations, where infants are not being addressed at all, should answer that question.

The target object that the model performed a novel action with in Experiment 1 was familiar to the infants. The infants knew what to do with the children’s spoon and the vocal message delivered by the second actor (“No, you don’t put it on your head”) in the non-imitation condition was thus consistent with the infants’ own experiences. It is possible that the infants in the non-imitation condition, hearing the second actor’s comments on the children’s spoon and observing her refraining from performing the novel action with the spoon, strengthened the infants’ decision not to imitate. However, watching the second adult actually imitate the unusual action may have encouraged the infants in the imitation condition to also imitate the action. To examine whether a second actor’s reactions encourage or reduce infants’ willingness to imitate, a study containing also a baseline condition, where the second actor does not imitate the target action and neither agrees or disagrees about the usage of the target object but, instead, makes neutral statements, may clarify whether a second adult’s response to the performance of another adult’s action influences infants’ tendency to imitate or not.

In Experiment 2, the target object that the model demonstrated was unfamiliar to the infants. We presume that the infants did not know how to handle the USB memory stick. There was no difference in imitation between the infants in the imitation and the non-imitation conditions. Whether the infants had observed the second actor imitate the model’s unusual action with the USB memory stick or not did not influence infants’ likelihood of imitating the behavior. It seems that the infants in Experiment 2 did not take into account the behaviors displayed by the second actor (imitating/not imitating) and, accordingly, did not use that information in order to guide their own actions with the object. However, given that the sample size in both Experiment 1 and Experiment 2 was rather low, the results of the two experiments should be interpreted with caution.

In both Experiment 1 and Experiment 2 there was just one adult (the second actor) who was imitating or not imitating the model’s novel action. It is possible that a given number of adults expressing a joint statement about what to do with a target object (familiar or unfamiliar) would influence infants’ willingness to imitate or not a novel action. For example, Haun, Rekers, and Tomasello (2012)

found that by two years, children are more prone to imitate an action performed by three demonstrators than an action performed three times by one demonstrator. Whether infants would rather take into account the opinions from several adults when deciding whether or not to imitate a novel action is an interesting question for future studies to answer.

In a previous study of infants' imitating in a third-party context (Stenberg, 2020) the model always acted as a knowledgeable teacher while the second adult acted like a novice learner. In the current study, however, the second adult either agreed with the model on how to use the target object or disagreed with the model concerning the usage of the object. The results from the present study suggest that in a third-party context, when infants receive information from an adult that contradicts their existing knowledge, they may take into account a second adult's behavior if it corresponds with their own experiences. When the infants in the present study did not have prior knowledge about how to use the target object, the behavior of the second adult did not seem to matter. From a social learning perspective, infants seem to be able to use prior knowledge and experience with objects, together with information received from third-party observations when deciding whether to imitate or not a certain action. Such findings extend our knowledge concerning infants' early social learning capacities.

However, due to the small sample size the results should be interpreted with caution. Moreover, a study containing a baseline condition would further clarify whether a second adult's response to the performance of another adult's action influences infants' tendency to imitate or not.

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