A variation of the social context in the warm-up period influences 18-month-olds’ imitation

Highlights

- 18-month-old infants profit from a model’s social behavior compared to a non-social behavior in a prior warm-up period.
- When the model acted socially prior to the imitation task, infants showed a higher overall imitation rate in contrast to the condition when the model acted non-socially.
- A detailed report about the models’ disposition during the warm-up period ought to be included in future studies to enable a better interpretation of the results concerning imitative performance.
Abstract

The present study aimed to investigate how the prior social disposition of a model in a warm-up period influences 18-month-old infants’ subsequent imitation. Infants were randomly assigned to an interactive and social warm-up period ($n = 19$) or a non-interactive and non-social warm-up period ($n = 19$) with the model prior to the imitation task. They then participated in an imitation task with different types of actions: novel means actions, arbitrary vs. functional actions and necessary vs. unnecessary actions. An additional social warm-up control group ($n = 14$) and a non-social warm-up control group ($n = 14$) were recruited to assess the spontaneous production of the target actions in the absence of the demonstration. The results showed that infants in the experimental groups performed significantly more target actions than infants in the control groups, showing an imitation effect. Furthermore, the results of the experimental groups showed that the overall imitation performance of the target actions was higher in the social condition than in the non-social condition. This imitation enhancing effect of the social warm-up period held true for the novel means actions and functional vs. arbitrary actions, however not for the necessary vs. unnecessary actions. Implications of the results for theory and future studies are discussed in terms of infants’ social motivation and its relation to infants’ imitative behavior.

Keywords: imitation, warm-up period, social motivation, social context
A variation of the social context in the warm-up period influences 18-month-olds’ imitation

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1. Introduction

Imitation refers to social learning in a broad sense, while following a much more strict terminology it means copying means and goals in a high fidelity manner. Imitation enables the acquisition of knowledge and skills in a relatively short time by avoiding time consuming trial-and-error learning (Bekkering, Wohlschlaeger, & Gattis, 2000) and is therefore an important learning mechanism especially during infancy and childhood.

Accordingly, for the last decades, the study of imitative development during infancy has received a tremendous amount of attention (Nadel, 2014). Most studies have been conducted with a standardized imitation paradigm (Meltzoff, 1985). In this experimental procedure, the infant observes a model performing target actions on one or a series of unfamiliar objects. After that, the objects are handed to the infant and imitative behavior is observed - either immediately, assessing action perception and action understanding, or after a delay, assessing long-term memory processes (Abravanel & Gingold, 1985).

As most studies on infants’ imitation involve an unfamiliar human model, the vast majority of studies conduct a warm-up period prior to the demonstration phase to make the infants familiar with the testing environment and the model. So far, however, the model’s sociability and the type of interaction during a warm-up period have not been systematically studied; a short warm-up period itself has been considered sufficient to elicit a high level of imitation and studies have freely chosen the form and content of it (Devouche, 1998).

There is some limited evidence in previous work, however, that a variation in the warm-up period could affect infants’ imitation performance. For example, Somogyi and Esseily (2014) reported that when the experimenter mimicked 16-month-old infants’ actions before a tool-use task, infants imitated the target actions with a higher rate than after a neutral warm-up period. Also, playing with the infants without mimicking them led to a better
performance than when infants played on their own. Zmyj, Schneider and Seehagen (2017)
showed that an extended warm-up phase led to a decrease of infants’ cortisol level. The
authors pointed out that an elevated stress level due to a short or non-existing warm-up period
might impair infants’ cognitive abilities during the test period. Furthermore, Nielsen (2006)
investigated more specifically the influence of a variation of the model’s prior sociability. In
this study, 18-month-old infants were assigned to one of two warm-up conditions. In the
“social” condition, the model was sitting during the warm-up period at a table and engaged in
a social interaction with the child (e.g., smiling, eye contact) while an assistant was playing
with the child and familiarized him/her with the room. In the “aloof” condition, the model was
absent during the warm-up period and met the child for the first time in the test room. In the
demonstration phase, infants watched the model retrieve a toy from a closed box by
disengaging a switch located on the front of the box. Although the box could be easily opened
by hand, the model opened the box by using an object. During demonstration, the model’s
actions were either accompanied by social-communicative cues (social condition) or the
model remained focused on the toy and avoided eye contact (aloof condition). The results
showed that 18-month-old infants’ imitative behavior was influenced by the social disposition
of the model. Infants imitated more exactly the specific object-use when the model acted
socially, but imitated selectively only the end-state of the action when the model acted aloof.

One theory that was suggested to explain these differences is the social affiliation
account which explains that infants’ exact versus selective imitation varies to the extent to
which they are motivated primarily by cognitive or social motivation (Carpenter, 2006; Over
& Carpenter, 2012; see also Užgiris, 1981). That is, in situations in which cognitive
motivation predominates, infants focus much of their attention on the functions of the objects
in order to learn a new skill and are accordingly mainly interested in attaining a particular
result. Consequently, they selectively imitate the elements of the demonstrated target actions
that are relevant for achieving that result. In contrast, in situations in which social motivation
predominates, infants seek to affiliate with the model and are interested in sustaining the
interaction. As a function of this social motivation to imitate, infants are more likely to match
their own behavior with the models’ behavior. Accordingly, the modeled target actions are
imitated more exactly by the infants, even if the actions are irrelevant to achieve a certain
outcome or to manipulate an object. Hence, it has been suggested that infants’ exact imitation
can be used as an indicator of social motivation (e.g., Carpenter, 2006; Van Etten & Carver,
2015). In contrast, alternative theories explain infants’ variation in imitative behavior
according to what infants interpret as the models’ intentions or goals to be: infants imitate the
modeled actions more exactly when no other end-state of an action could be perceived as a
goal. However, when a clear final end-state is present, infants selectively imitate only the
relevant actions in order to achieve the goal (Bekkering et al., 2000; Carpenter, Call, &
Tomasello, 2005). Since this account cannot explain why infants in the social condition
imitated also the unnecessary actions although the end-state was clear to distinguish (Yu,
2015), support for the social affiliation account seems to be more plausible.

There are, however, some important limitations in previous studies that preclude a
precise understanding of how the prior social disposition of the model in a warm-up period
influences infants’ subsequent imitation. First, in Nielsen’s (2006) study, the assistant and not
the model had a warm-up period with the infant in the social condition. Hence, no active
interaction between the model and the infant took place. Furthermore, in the aloof condition,
the model did not meet the infant before the demonstration phase and was, accordingly, an
unfamiliar person for the infants. Second, as the use of social-communicative cues was varied
between the social vs. aloof condition in the demonstration phase as well, it is not clear
whether the disposition of the model in the warm-up period was the only factor that could
have had an impact on infants’ imitation.
Third, infants’ exact imitation was investigated with only one action type, whereas in other previous studies, exact imitation was also measured with different action types. For example, the first type of imitation task measures the acquisition of novel means actions, which are unusual novel actions to produce an interesting effect on novel objects even though the same effect could be easily achieved by more familiar means (e.g., using one’s forehead instead of one’s hand to turn on a light, see Meltzoff, 1988; Herold & Akhtar, 2008). A list of studies showed that the social-communicative context had an effect on infants’ exact imitation of novel means actions (e.g., Király, Csibra, & Gergely, 2013; Shimpi, Akhtar, & Moore, 2013).

The second type of imitation task varies the functionality of target actions (see Óturai, Kolling, Rubio Hall, & Knopf, 2012). Functional actions are those that require specific object properties and are thus strongly connected to the objects, whereas arbitrary actions do not require specific object properties and thus could be performed on a wide range of objects. Óturai et al. (2012) showed that 12-month-old infants only imitated the functional actions, whereas 18-month-olds imitated both kinds of actions. The authors pointed out that the imitation of arbitrary actions observed in older infants may serve social functions.

The third type of imitation task is a two-action sequence on an object in two different causal contexts. In the necessary condition, the first action is causally necessary in order to execute the second action that yields the effect (e.g., producing a sound by pressing a button on the object). In the unnecessary condition, the first action is causally unnecessary in order to execute the second action. Hence, in former studies, exact imitation as evidenced by imitation of first action in the unnecessary condition was used as an indicator for the social motivation to imitate (e.g., Hilbrink, Sakkalou, Ellis-Davies, Fowler, & Gattis, 2013).

In the present study, then, we investigated whether 18-month-old infants’ imitative behavior differs upon a social warm-up period versus a non-social warm-up period with the
model prior to the imitation task. Importantly, to ensure that any differences found in imitation across conditions were due to the different prior social conditions, the model used social-communicative cues during the demonstration phase in both conditions. Furthermore, in order to assess if infants’ imitation rate in the experimental groups is above the rate of spontaneous propensity to produce the target actions in absence of a demonstration, two control groups were used. They were treated the same as the experimental groups - one control group had a social warm-up period and the other control group had a non-social warm-up period - with the difference that no target actions were modeled. Additionally, to consider if a variation of the models’ sociability in the warm-up period has an effect on infants’ exact imitation across different action types, the above-mentioned three different action types were chosen.

The present study tested the following predictions: First, we expected that infants in both conditions (social warm-up vs. non-social warm-up) of the experimental groups would perform above the rate of spontaneous production of target actions by infants in the control groups. Second, to the extent that infants’ affiliation with the model is hypothesized to facilitate imitative learning (e.g., Brugger, Lariviere, Mumme, & Bushnell, 2007) we expected that a social condition would lead infants to imitate the model’s actions more frequently than infants in a non-social condition. Finally, based on previous findings which suggested a correspondence between infants’ social motivation to imitate and exact imitation (e.g., Carpenter, 2006; Hilbrink et al., 2013; Yu & Kushnir, 2014), we anticipated that infants in the social condition would imitate irrelevant actions (actions having no clearly visible outcome or causal function) more frequently than infants in the non-social condition due to their higher social motivation to sustain interaction and affiliate with the model and that this difference would hold true across the three different action types.

2. Method
2.1. Participants

A total of sixty-six healthy, 18-month-old infants ($M = 18$ months 22 days; $SD = 33$ days, 29 girls) participated in the study. Three additional infants were tested but not included in the final sample due to technical problems ($n = 1$) or lack of cooperation ($n = 2$). All participating infants were typically developing, with a mean birth weight of $M = 3285$ g (minimum 2600g, maximum 4300g, $SD = 526.5$).

2.2. Materials and target actions

Novel means actions. Two target objects adapted from former studies (e.g., Herold & Akhtar, 2008; Shimpi et al., 2013) were used. The first one was a white push-on circular light which was activated by applying pressure to it. The second one was a round table bell which produces a ringing sound when pressing the top of it. The model demonstrated one target action on each of the objects: to activate the lamp, the model leaned forward and touched its top with her forehead ('headtouch’ task; see also Meltzoff, 1988). To activate the table bell, the model used one elbow to press the top. The hands were unoccupied and clearly visible on the tabletop during both target action demonstrations.

Functional vs. arbitrary actions. Six target objects of the Frankfurt Imitation Test for 18 Month Old Children were used (FIT 18, see Goertz, Kolling, Frahsek, & Knopf, 2008). The model demonstrated two target actions with each of the six objects: a functional and an arbitrary one adapted from Óturai et al. (2012). For example, clicking a metal box onto a magnetic toy cow’s belly is defined as a functional action as the child can discover the function of the magnet. In contrast, lifting the toy cow with the metal box on the belly and placing it back on the table is defined as an arbitrary action.

Necessary vs. unnecessary actions. Two target objects adapted from a former study (Hilbrink et al., 2013) were used. The first one was a wooden box and the second one was a toy train. Each object was used once in the necessary condition and once in the unnecessary
condition, with modifications for each condition so that there were four different toys in total. In the necessary condition, the first action was necessary in order to perform the second action which always led to an effect. In the unnecessary condition, the first action was irrelevant to the second action which leads to an effect. The first object was a wooden box which had a lid that could be pulled open with a knob to reveal a hidden ball. In the necessary condition, a Velcro latch was attached to the lid of the box that needed to be removed before the lid could be opened. The model’s first action was to remove the Velcro latch, which was a necessary action, and the second action was to open the lid. In the unnecessary condition, the Velcro latch was positioned on the other half of the box which did not hold the lid shut. The model’s first action was to remove the Velcro latch on the other half of the box, which was unnecessary to perform, and the second action was to open the lid. The second object was a toy train which contained two puppets, one in the front seat and one in the back seat. Pushing the puppet in the front seat of the train caused music to play. In the necessary condition, a blue plastic cover in a form of a pyramid was placed over the puppet in the front seat of the train. The model’s first action was to remove the cover from the puppet in the front seat and the second action was to push the puppet in order to make a noise. In the unnecessary condition, the cover was placed over the animal in the back of the train. In this condition, the model’s first action was to remove the cover from the puppet in the back seat, which was unnecessary to perform, and the second action was to push the puppet in the front seat in order to make a noise.

2.3. Design and procedure

Infants were randomly assigned to either the social warm-up experimental group (n = 19) or the non-social warm-up experimental group (n = 19). A social warm-up control group (n = 14) and a non-social warm-up control group (n = 14) were recruited to assess the spontaneous production of the target actions in the absence of the demonstration. Upon arrival
at the university, the infant and parent(s) were escorted to a quiet lab room. The warm-up
day began after the purpose and procedure of the study were explained to the parent(s) and
written informed consent was obtained. The warm-up period lasted for 8 minutes in each
condition. This time period was chosen as a previous study (Bretherton, 1978) showed that
after 8 minutes of play infants were able to establish a rapport with an unfamiliar adult.

To control for effects based on temporal order of action presentation, the infants in the
experimental groups were randomly assigned to different presentation orders. In the case of
functional vs. arbitrary actions, the order of target actions was varied in an incomplete
counterbalanced design. In the condition “presenting order 1” (n = 19) the functional actions
were presented firstly for the second, the third and the sixth item and the arbitrary actions
were presented thereafter. In the condition “presenting order 2” (n = 19) the arbitrary and
functional actions were presented in the reversed order. In the case of necessary vs.
unnecessary actions, infants were shown both types of target objects in both conditions in one
of four possible orders counterbalanced across infants: (1) wooden box necessary, toy train
unnecessary, wooden box unnecessary, toy train necessary (n = 10), (2) wooden box
unnecessary, toy train necessary, wooden box necessary, toy train unnecessary (n = 10), (3)
toy train necessary, wooden box unnecessary, toy train unnecessary, wooden box necessary (n
= 9), (4) toy train unnecessary, wooden box necessary, toy train necessary, wooden box
unnecessary (n = 9).

2.3.1. Social warm-up period

The model started the warm-up period by picking up a ball and saying ‘Look [Infant’s
Name], let’s play with the ball’. The model actively initiated reciprocal games such as ball-
games (rolling the ball back and forth) as well as give-and-take games (giving the ball and
requesting it) that establish a social rapport. All infants accepted the model’s offer of a toy at

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1 The study has been conducted in full accordance with the ethical guidelines of the German Psychological Society and is also in line with the Ethical Principles of Psychologists and Code of Conduct of the American Psychological Association.
least once, directly from the model’s hand or indirectly (e.g., by catching the ball) and also
initiated a social interaction at least once, by giving the model a toy. The model maintained
and initiated eye contact, smiled at the infant and vocalized the infant’s behavior during this
condition.

2.3.2. Non-social warm-up period

The model started the warm-up period by saying ‘Look, you can play with the toys
over there’. The parent(s) were asked to engage in play with the child. The model was sitting
beside at a desk on a chair and there was no active interaction between the model and the
infant. The model did not talk to the infant and avoided eye-contact during this condition.

2.3.3. Demonstration of target actions

After the warm-up period the demonstration phase began. The infant and the parents
were escorted to a table that was behind a partition wall in the same room. The infant was
seated on the caregiver’s lap opposite to the model. The model retrieved the first object from a
hidden container below the table and placed it on the table in front of the infant. Then, the
model started to demonstrate the target action, saying: “Look, [Name], I will show you
something!” The model demonstrated the target action two times within roughly 30 seconds.
Then, the object was handed over to the infant while the model said: “Now it’s your turn”.
The infant was given 30 s to play with the object starting from the moment when the model
removed her hands from the object. The same procedure was repeated for all target objects.
The infant and the model were videotaped by two cameras.

2.3.4. Control conditions

After the warm-up period, the infant and the parents were escorted to a table that was
behind a partition wall in the same room. The experimenter placed the first object in front of
the infant and directed the infant’s attention to it, saying: “Look, [Name], you can play with
this.” After 30 seconds, the experimenter removed the object and put the next object on the
table, saying: “Look, [Name], now you can play with this one”. The same procedure was
repeated for all target objects.

2.4. Coding procedure

A naïve rater scored the performance of target actions in the videotaped sessions. One
third of the videotapes was also scored by a second rater and a good inter-rater reliability was
obtained, $k = .83$ ($p < .001$). For each task infants received a score of 1 when they produced
the target action and otherwise a score of 0. Therefore, infants could receive an imitation
score from 0 to 2 for the novel means actions (head touch task, elbow task), a score from 0 to
2 for overall goal attainment by any means (put the light on, ring the bell by either using the
hand or using the novel means), a score from 0 to 6 for the functional actions, a score from 0
to 6 for the arbitrary actions. In the case of the necessary vs. unnecessary actions, the focus
was on the first action as the second actions remained constant between the social vs. non-
social conditions (see also Brugger et al., 2007; Hilbrink et al., 2013). Accordingly, infants
could receive an imitation score from 0 to 2 for the first actions in the unnecessary condition
and a score from 0 to 2 for the first actions in the necessary condition (toy train task, box
task). Target objects, actions and possible imitation scores are shown in Table 1.
### Table 1

**Test objects and target actions**

<table>
<thead>
<tr>
<th>Action type</th>
<th>Object</th>
<th>Relevant action</th>
<th>Max.</th>
<th>Irrelevant action</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Novel means actions</strong></td>
<td>Lamp</td>
<td><strong>Goal attainment</strong></td>
<td></td>
<td><strong>Novel means actions</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn on the light</td>
<td></td>
<td>Using the forehead to turn on the light</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child press the lamp with one or both hands even if the child’s press was too weak to actually turn on the light</strong></td>
<td></td>
<td>Will be coded as yes, if the child use any part of the face or head</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bell</td>
<td>Activate the bell</td>
<td></td>
<td>Using the elbow to press the bell</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child press the bell with one or both hands even if the child’s press was too weak to actually ring the bell</strong></td>
<td></td>
<td>Will be coded as yes, if the child twists the arm and touches the bell with the back of the wrist, fist or forearm</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Functional action</strong></td>
<td></td>
<td></td>
<td><strong>Functional action</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ship</td>
<td>Putting a hand into the ship and waving</td>
<td>6</td>
<td>Taking the ship from one hand to another and back</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child puts a hand into the ship</strong></td>
<td></td>
<td>Will be coded as yes, if the child take the ship from one hand to the other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cow and metal box</td>
<td>Clicking the box on the cow’s belly</td>
<td></td>
<td>Lifting the cow from the table and placing it back</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child clicks the box on the cow’s belly, even if the magnets do not hold</strong></td>
<td></td>
<td>Will be coded as yes, if the child lifts the cow and places it back on the table, regardless if the metal box is in the belly</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mouse</td>
<td>Shuting the mouse</td>
<td></td>
<td>Moving the mouse on a curvy path</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child clicks the mouse, even if she/he is too weak to produce a noise</strong></td>
<td></td>
<td>Will be coded as yes, if the child pushes the mouse forwards on the table, regardless if the path is curvy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frog and ring</td>
<td>Putting a finger into the frog and holding it upright</td>
<td></td>
<td>Sitting the frog into the ring and sliding it to and fro</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child puts a finger into the frog</strong></td>
<td></td>
<td>Will be coded as yes, if the child slides the frog to and fro on the table, regardless if the frog is sitting in the ring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drum</td>
<td>Pressing the red button</td>
<td></td>
<td>Sliding the drumstick around the drum</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child presses the red button on the drum</strong></td>
<td></td>
<td>Will be coded as yes, if the child slides the drumstick around or next to the drum</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duck and octopus</td>
<td>Sitting the duck in the octopus</td>
<td></td>
<td>Turning the duck</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child places the duck onto the octopus</strong></td>
<td></td>
<td>Will be coded as yes, if the child turns the duck, regardless if it is sitting on the octopus</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Necessary first action</strong></td>
<td></td>
<td></td>
<td><strong>Necessary first action</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Box</td>
<td>Removing the Velcro latch attached to the lid of the box which is opened</td>
<td>2</td>
<td>Removing the Velcro latch attached to the other half of the box which did not hold the lid shut</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child grabs the latch and tries to remove it even if she/he is too weak to remove it</strong></td>
<td></td>
<td>Will be coded as yes, if the child grabs the latch and tries to remove it even if she/he is too weak to remove it</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toy train</td>
<td>Removing the cover from the puppet in the front seat</td>
<td></td>
<td>Removing the cover from the puppet in the back seat</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Will be coded as yes, if the child lifts the cover up from the puppet</strong></td>
<td></td>
<td>Will be coded as yes, if the child lifts the cover up from the puppet</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Infants received one point for each action.
3. Results

3.1. Preliminary analysis

ANOVA were used to test whether the imitation rate differed between the presentation order conditions. The presentation order of functional vs. arbitrary actions had no significant effect on the imitation rate, $F(1, 36) = 2.10, p = .156$. Also, the presentation order of necessary vs. unnecessary action had no significant effect on the imitation rate, $F(3, 34) = 1.24, p = .310$. This factor was therefore not included in any of the following analyses.

3.2. Overall analysis of imitation

The results showed that infants in the experimental groups performed $M = 10.47$ ($SD = 2.96$) target actions while infants in the control groups performed $M = 3.50$ ($SD = 1.20$) target actions. A 2 (group: experimental vs. control groups) x 2 (condition: social vs. non-social) ANOVA was used for an overall analysis of imitation. A significant main effect of group was found, $F(1, 62) = 173.72, p < .001, r = .86$, indicating that infants in the experimental groups performed significantly more target actions than infants in the control groups. Hence, an imitation effect was shown. Also, a significant main effect of condition was found, $F(1, 62) = 7.02, p = .010, r = .32$, indicating that infants in the social condition performed significantly more target actions than infants in the non-social condition. The interaction between group and condition was also significant, $F(1, 62) = 8.53, p = .005, r = .35$. This interaction shows that the experimental groups and the control groups were affected differently by condition. Planned comparisons revealed that the imitation rate in the social ($M = 3.43, SD = 1.09$) and non-social condition ($M = 3.57, SD = 1.34$) did not differ in the control groups, $t(26) = .31, p = .760, r = .06$; however, the imitation rate was significantly higher in the social condition ($M = 11.95, SD = 2.59$) than in the non-social condition ($M = 9.00, SD = 2.58$) in the experimental groups, $t(36) = -3.51, p = .001, r = .72$.

3.3. Imitation performance for different action types
3.3.1. Imitation of novel means as a function of condition

An independent \( t \)-test revealed that infants in the social condition (\( M = 1.42, SD = 0.77 \)) showed a significantly higher imitation rate of the novel means actions (put the light on by using the head, use the elbow to ring the bell) than infants in the non-social condition (\( M = 0.68, SD = 0.82 \)), \( t(36) = -2.858, p = .007, r = .54 \). Additionally, to examine if infants in the social vs. non-social condition showed differences in achieving the end-state of the action, the overall goal attainment by any means (put the light on, ring the bell by either using the hand or using the novel means) in the two conditions was investigated. The results showed no significant difference between infants in the social (\( M = 1.89, SD = 0.46 \)) and non-social condition (\( M = 1.58, SD = 0.61 \)), \( t(36) = -.651, p = .519, r = .11 \), showing that infants in the non-social condition and social condition achieved the end result of the action at a similar rate.

3.3.2. Imitation of arbitrary vs. functional actions as a function of condition

The data of arbitrary vs. functional actions were analyzed using a 2 (condition: social versus non-social) x 2 (action type: arbitrary versus functional) mixed model ANOVA. Condition was a between-subject factor and action type was a within-subject factor. A significant main effect of condition was found, \( F(1, 36) = 8.56, p = .006, r = .44 \), indicating that, overall, infants in the social condition (\( M = 7.63, SD = 2.00 \)) performed significantly more actions than infants in the non-social condition (\( M = 5.79, SD = 1.93 \)). Also, a significant main effect of action type was found, \( F(1, 36) = 105.78, p < .001, r = .86 \), indicating that, overall, infants imitated significantly more functional actions (\( M = 4.50, SD = 1.33 \)) than arbitrary actions (\( M = 2.21, SD = 1.18 \)). The interaction between action type and condition was not significant, \( F(1, 36) = .014, p = .907, r = .01 \).

3.3.3. Imitation of necessary vs. unnecessary actions as a function of condition
The data of necessary vs. unnecessary actions were analyzed using a 2 (action type: necessary vs. unnecessary) x 2 (condition: social vs. non-social) mixed model ANOVA. Condition was a between-subject factor and action type was a within-subject factor. A significant main effect of action type was found, $F(1, 36) = 31.85, p < .001, r = .47$, indicating that, overall, infants imitated significantly more necessary actions ($M = 1.71, SD = 0.46$) than unnecessary actions ($M = 1.00, SD = 0.74$). However, no significant main effect of condition was found, $F(1, 36) = 1.52, p = .226, r = .04$, indicating that infants in the social condition ($M = 2.89, SD = 0.86$) did not perform significantly more actions than infants in the non-social condition ($M = 2.53, SD = 0.96$). Also, the interaction between action type and condition failed to meet significance, $F(1, 36) = 3.54, p = .68, r = .09$.

4. Discussion

Most imitation studies conduct a warm-up period, but the form and content has not been systematically controlled so far. The present study investigated whether 18-month-old infants’ imitative behavior differed upon a social warm-up period versus a non-social warm-up period with the model prior to the imitation task. First, as predicted, the present findings show a broad effect of infant learning regardless of warm-up condition. Infants imitated significantly more actions in the experimental condition than in the control condition. Furthermore, the results showed that infants imitated significantly more functional than arbitrary actions and were also more likely to imitate the first action if it was necessary than if it was unnecessary to perform. These results demonstrate that 18-month-old infants are tuned to imitate and learn important, relevant actions and show an understanding of the causal relations embedded in the task, replicating previous findings (Brugger et al., 2007; Hilbrink et al., 2013; Óturai et al., 2012).

Second, the present findings confirmed our expectations that 18-month-olds’ imitative behavior is guided by the model’s social nature during a warm-up period. The results show
that 18-month-old infants profit from a model’s social behavior compared to a non-social behavior. When the model acted socially prior to the imitation task, infants showed a higher overall imitation rate than when the model acted non-socially. Importantly, this was shown even though the model was social during the demonstration phase in both conditions. Hence, the present result is consistent with the proposal that what impacts on infants’ imitation behavior is not simply the familiarity with the model but the nature of the relation that is built between the model and the infant (Devouche, 1998; see also Nielsen, Simcock, & Jenkins, 2008).

Third, as expected, the results of the present study also demonstrate that 18-month-old infants were more likely to imitate the specific target actions when the model acted socially, even if those actions were irrelevant to achieve a certain end-state. Interpreted in the framework suggested by Nielsen (2006) and Over and Carpenter (2012), these results indicate that as a part of their desire to affiliate and sustain social interaction, infants in the social condition were more motivated to exactly match their behavior to a model’s clearly suboptimal and inefficient actions to reach a goal. As exact imitation can be used as an indicator for social motivation, these results shows that as a part of their desire to affiliate, a variation of the models’ sociability in a warm-up period prior to the imitation task has a powerful influence on infants’ social motivation, and thus on what they imitate. These findings are also relevant to previous empirical work suggesting that children may imitate irrelevant actions as a way of learning about social or cultural norms (e.g., Nielsen & Blank, 2011). The imitation of all modeled actions that are demonstrated in a purposeful way could be potentially useful in learning the rules and conventions of society (see Kenward, Karlsson, & Persson, 2011). Hence, the present results suggest that closer rapport with the model could lead to infants becoming more open to the model’s “norms” of using a tool.
However, the extent to which infants’ imitation behavior was influenced differed depending on the type of action that was demonstrated. For the novel means actions, the results confirmed our expectation that infants in a social warm-up period would engage in more imitation: they imitated the observed (unusual and clearly suboptimal) head-, and elbow- action to achieve the goal significantly more often than infants in the non-social warm-up period who achieved the same final goal, but used rather the more efficient hand action. These findings are in line with the results of Shimpi et al. (2013) showing that infants were more likely to imitate novel means actions if they had prior social experience with the model (familiarization phase) than if they had not met the model before. Our findings furthermore extend these results by showing that not only the presence or absence of a familiarization phase but also the sociability of a model in the warm-up period prior to demonstration has influence on infants’ subsequent imitation of novel means actions. Furthermore, for the arbitrary actions, the results also confirmed our hypothesis that infants in a social warm-up period would engage in more imitation. However, for the unnecessary actions, contrary to our expectations the infants in a social warm-up period did not engage in more imitation.

Why did infants imitate differently with respect to the type of actions? A possible explanation could be that at 18 months of age, the influence of the social context during a warm-up period interacts with infants’ cognitive motivation to learn. In case of novel means actions, there was nothing ‘new’ to learn regarding the manipulation of the objects. Infants had a choice between achieving a goal by imitating novel means or just easily use their hands and the present results demonstrate that a social interaction with the model in the warm-up period led infants to engage more frequently in exact means-directed imitation. However, in case of the functional vs. arbitrary and necessary vs. unnecessary actions, the modeled actions included new learning aspects of attaining a particular result or state by manipulation of the
objects. This could have led to a priority of achieving end-results as a goal, which made it to
be selected over other, social, goals. Hence, infants were not sufficiently motivated by the
social warm-up period to imitate actions that are irrelevant and disregarded their prior
interaction with the model in favor of their own judgement about whether the elements of the
demonstrated target actions are relevant to achieve an overarching end-state in a two- (or
more) action sequence.

One critical aspect of the present study that has to be acknowledged is that the warm-
up periods were not video recorded and therefore information about the exact numbers and
durations of eye-contact, give-and-take games etc. could not be reported precisely. Hence, a
more detailed report and analysis of manipulations in the warm-up period based on video
coding remains an important topic for future studies. Moreover, further research is needed to
explore whether the present results hold for different age groups as well.

5. Conclusions

Overall, the current study is an important step into exploring the influence of the social
context during a warm-up period on infants’ subsequent imitation, which has rarely been
addressed in empirical work so far. In the light of the present findings, two main points should
be considered in future research. First, researchers need to be cautious when interpreting
results only as an account for capacity, thereby disregarding the influence of motivation
(Zmyj, Daum, Prinz, Nielsen, & Aschersleben, 2012). Second, a detailed report about the
form, content and the models’ disposition during the warm-up period ought to be included in
future studies to enable a better interpretation of the results concerning imitative performance.

Acknowledgements

We would like to thank all the infants and their families who participated in this study.
References


