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“I wanna be like you”: testing the link between social affiliation and overimitation in infancy

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Introduction: One way children learn is through imitation, an important ability to gain new skills and to share cultural knowledge. Overimitation, or the tendency to copy irrelevant actions to achieve a goal, is one specific type of imitation which may be particularly related to social motivations. Various theoretical accounts have been developed to explain this construct, including that one overimitates to affiliate with the demonstrator. However, it is still unclear what mechanisms underlie overimitation and how early it develops. The goal of the current experiment was to examine the emergence of overimitation in infancy and its link with social affiliation and other forms of imitation.

Methods: We administered to 16- to 21-month-olds an overimitation task adapted for infants, an elicited imitation task, an unfulfilled intentions imitation task, and an in-group preference task, used as a measure of social affiliation. We expected an association between the performance on the different imitation tasks, but a weaker link with overimitation. It was also predicted that performance on the in-group preference task would be more strongly related to the overimitation task than to the other imitation tasks.

Results and discussion: Results showed a significant association between the elicited and unfulfilled intentions imitation tasks, but no link between overimitation and in-group preference. To our knowledge, this is one of the first experiments to study overimitation in infancy and to attempt to find an association with other forms of imitation and with a separate and direct measure of in-group preference as a proxy for social affiliation.

KEYWORDS

overimitation, imitation, social affiliation, in-group preference, infancy

Introduction

Children learn in many different ways. One dominant way to learn is through social learning, that is, by observing and interacting with others, for example through imitation. Imitation is considered a foundational skill in development, as it is one of the most important ways through which culture, rituals, norms, and traditions are transmitted across generations (Heyes, 2023; Nielsen, 2012). Imitation abilities can also inform us on how relationships are created and maintained (Over, 2020), so it is crucial to document its development early in life. The present study aimed to examine the development of different forms of imitation in infancy in order to determine how they may be related to each other and to social affiliation.

Imitation can be defined as reproducing an action after watching a person perform that action (Nielsen, 2009; Over, 2020). It develops early in life, and it increases with age (e.g., Bellagamba et al., 2006; Gellén and Buttelmann, 2019; Jones, 2007). Among the various ways to measure it in children, imitation can be elicited, such as when children are asked to repeat a sentence (for example to assess language proficiency;

Kostromitina and Plonsky, 2022) or more commonly to accurately recreate an action or a sequence of actions (Bauer and Mandler, 1989; Chiarella and Poulin-Dubois, 2018; Over, 2020), which requires memory skills. Memory is also important in deferred imitation, for example when measuring infants' accuracy of imitation after a delay (e.g., Óturai et al., 2012, 2013, 2018). Other cognitive abilities may also be needed for imitation, such as a theory of mind, which is the capacity to understand others' mental states (Ruffman, 2014; Wellman, 2014). This is the case for imitation tasks assessing unfulfilled intentions, such as when a model demonstrates a failed action (Meltzoff, 1995).

Imitation can be instrumental to learn a new skill, but it is also social in nature (Hoehl et al., 2019). Multiple examples of this double function of imitation exist in the literature. For instance, children imitate to affiliate with others, as evidenced by the fact that they prefer to imitate an in-group member, such as someone who speaks the same language as them (Altinok et al., 2022; Buttelmann et al., 2013; Howard et al., 2015). Such a positive evaluation of individuals who speak a familiar language has been established in infants as young as 5 months old (Kinzler et al., 2007; Pun et al., 2018). Interestingly, Sommer et al. (2021) found that 1- to 3-year-olds imitated a social robot model, and that this behavior increased with age, but to a lesser extent than when copying a human agent, again suggesting a preference for in-group members (i.e., human) over out-group members (i.e., robot).

Children can also infer information from observing interactions that involve imitation. Using a looking paradigm, Liberman et al. (2018) found that 16-month-olds expected individuals who performed an action in the same way (i.e., turning on a light with their head) to affiliate rather than socially disengage compared to individuals who did the action differently (i.e., turning on the light with their head vs. their elbow). Results from Powell and Spelke (2018) also show that 4- to 5.5-month-old infants expected that characters from a video animation who imitated another would affiliate with the characters they copied. Similarly, infants expected both imitators and targets of imitation to respond to distress expressed by their social partner (Kudrnova et al., 2024).

Finally, children use imitation as a way to communicate with their social partner (Over, 2020). For instance, a recent study by Altinok et al. (2023) with 5-year-olds used a barrier to hide the preschooler's view of an experimenter, who had previously demonstrated an action to imitate. To make sure the experimenter could see them imitate, preschoolers reproduced the action over the barrier, often at the cost of accuracy. Overall, then, multiple lines of research support the idea that imitation has a social function and is linked to social constructs, even in infancy.

One specific type of imitation for which the social function is particularly salient is overimitation (also called faithful or exact imitation), which can be defined as when one copies actions that are not necessary to achieve a certain goal (Hoehl et al., 2019). For example, a child would overimitate if they copy all actions demonstrated by an experimenter when opening a box, even those that are irrelevant, like tapping on the box (e.g., Dragon and Poulin-Dubois, 2023; Horner and Whiten, 2005; Nielsen and Blank, 2011). This behavior increases with age (Hoehl et al., 2019), is present even in adulthood (e.g., Whiten et al., 2016), is observed cross-culturally despite slight cultural differences in the amount of overimitation (e.g., Clegg and Legare, 2016; Nielsen and Tomaselli, 2010; Stengelin et al., 2020), and seems to be uniquely present in humans (Horner and Whiten, 2005; but see Allen and Andrews, 2024 for a review on the overimitation literature in non-human species). It is also quite pervasive, as children overimitate even when it is at the cost of getting a greater reward (Nielsen et al., 2023), when they are aware of a more efficient strategy (Speidel et al., 2021), or in settings where they do not know they are taking part in an experiment (Whiten et al., 2016).

Overimitation has been extensively studied in recent years, and various theoretical accounts have been developed to explain this phenomenon (Hoehl et al., 2019). For example, Lyons et al. (2007, 2011) theorized that people overimitate because all actions demonstrated are encoded as relevant and instrumental to the goal presented (i.e., automatic causal encoding theory). Whiten et al. (2005, 2009) proposed a similar theory whereas irrelevant actions are imitated because they are interpreted as achieving an ambiguous goal. However, much like imitation and perhaps even more so, overimitation appears to be inherently social. Thus, many researchers have posited that individuals overimitate for social reasons, including normative pressures (Kenward, 2012; Kenward et al., 2011), such as when the model stays in the room compared to when they leave, which has been found to have an impact on the rate of overimitation across cultural groups (Stengelin et al., 2019). Other researchers maintained that one overimitates to affiliate with the model (e.g., Nielsen and Blank, 2011; Over and Carpenter, 2012). In fact, findings in the literature suggest a natural inclination for affiliative agents, as infants as young as 8 months prefer an "approacher" agent over a "repulser" agent (Geraci et al., 2022), a tendency also seen in chicks (De Roni et al., 2023). Support for the social affiliation account of overimitation includes research showing that children engage in more overimitation when the model is similar or familiar to them (Price et al., 2017; Rawlings et al., 2019) but equally or less so when it is a humanoid robot (e.g., Schleihauf et al., 2021; Sommer et al., 2020) or a human-like puppet (e.g., Dragon and Poulin-Dubois, 2023; Stengelin et al., 2023).

Group membership also has an impact on overimitation, again supporting the social affiliation hypothesis. For example, in a study by Gruber et al. (2019), preschoolers were more likely to overimitate when the model was identified as a member of their "team" compared to someone who was not. Interestingly, children aged 5–6 years imitated more accurately when they were previously rejected by an in-group member compared to when they were included, which the authors proposed is in line with the idea that children imitate as a way to show their desire to be a part of their in-group (Watson-Jones et al., 2016). In a more recent study, younger preschoolers showed a similar pattern of results but older preschoolers overimitated more when they were included compared to when they were ostracized in a game of ball-tossing (Testa et al., 2025). Moreover, there is some evidence that children who struggle socially, such as those diagnosed with autism spectrum disorder, copy fewer irrelevant actions compared to typically developing children (e.g., Marsh et al., 2013; Over, 2020; Vivanti et al., 2017). However, this finding is not consistent in the literature, as some studies show that they engage in overimitation at a similar rate (e.g., Nielsen and Hudry, 2010; Nielsen et al., 2013; Frazier and Henchell, 2021), which may be explained by the variability in the social skills of children with autism spectrum disorder (Over, 2020). In summary, in line with the social affiliation theoretical account, the tendency to overimitate is greatly influenced by social factors and by a desire to affiliate with the model. In fact, as reviewed above, manipulating the characteristics of the model has been found to influence overimitation. However, no link has been found between overimitation and a parental questionnaire of social affiliation abilities in preschoolers, in an attempt to measure social affiliation differently (Dragon and Poulin-Dubois, 2023). Although this may indicate that overimitation is only associated with social affiliation when it is linked to the model, to our knowledge, no study has associated performance on an overimitation task to a distinct measure of social affiliation, which is one of the main goals of the present experiment.

Although imitation skills are well-documented, the developmental origins of overimitation are less so. Yet, such knowledge is of outmost importance for a better understanding of the cognitive mechanisms underlying overimitation. The bulk of the research on overimitation has been conducted with preschoolers (i.e., 3- to 5-year-olds), so studies with infants are scarce. Many studies with this age group have used a task that included unusual or unconventional, but not causally irrelevant, actions thus not measuring overimitation *per se*. For example, in a "novel means" test, the model turned on a light with their forehead, elbow, or by sitting on it, rather than using their hand (e.g., Altinok et al., 2022; Buttelmann et al., 2013; Gellén and Buttelmann, 2019; Gergely et al., 2002; Liberman et al., 2018; Stahl and Woods, 2022).

Other tasks involve a test of necessary/unnecessary actions. One study looked at selective and faithful imitation longitudinally in 12- and 15-month-olds (Hilbrink et al., 2013). Participants were shown how to operate objects using a sequence of two actions in which the first action was either necessary or unnecessary to the second action. The task was scored according to if infants copied the first action demonstrated by the experimenter. Importantly, the researchers defined selective imitation as copying more causally relevant actions (i.e., first actions in the necessary vs. the unnecessary condition) and faithful imitation as copying both relevant and irrelevant actions (i.e., first actions in both the necessary and unnecessary conditions). Results showed that although selective imitation was present at both ages, faithful imitation increased with age.

Finally, overimitation has been studied by contrasting imitation of functional and arbitrary actions. Functional actions are related to the object's properties while arbitrary actions are not specific to a particular object (Óturai et al., 2012, 2013). For example, Óturai et al. (2012, 2013, 2018) demonstrated to 12-, 18-, and 24-month-old infants functional and arbitrary actions with various objects (e.g., attaching a magnetic box to a plush cow vs. lifting the cow from the table, respectively). They then measured infants' imitation after a 30-min delay, in which infants could play freely. Across these studies, researchers found that infants tended to imitate more functional than arbitrary actions, but that the rate of imitation of arbitrary actions (i.e., exact imitation) increased with age (Óturai et al., 2012, 2013, 2018). Another study revealed that 19-month-old participants imitated both "manner" (irrelevant or arbitrary) actions and "goal" (functional) actions after being shown how to operate different objects (Howard et al., 2015). Although the studies presented above examined a form of faithful or exact imitation, the tasks used and the conceptualization of the constructs were different from what is typically found in the overimitation literature with older children. To our knowledge, no study on overimitation in infancy has tested causally irrelevant actions like in the preschool literature.

We pursued multiple goals with the present experiment. First, we aimed to study overimitation in infancy using a task adapted from the preschool-aged literature, to determine how early overimitation develops. This task measures children's tendency to copy irrelevant or arbitrary actions when opening a box to get a toy inside (e.g., tapping on the lid before opening it).

Second, we wanted to test social affiliation directly, with an in-group preference task using a human and a robot agent. Children have been shown to treat robots differently than humans. At the age of 3, preschoolers know that a person has biological insides but are unsure of what goes inside a robot (Baumann et al., 2024). More importantly, evidence in the literature show that infants do not expect an unfamiliar robot to move on their own but are unsurprised when an unfamiliar human does so (Poulin-Dubois et al., 1996). Moreover, although 18-month-olds follow the gaze of a robot, they do not learn new words from it (O'Connell et al., 2009). Similarly, 12-month-olds follow the gaze of both a robot and a human but only understand the referential nature of the gaze of the human (Okumura et al., 2013a), and learn about an object only from the human gaze (Okumura et al., 2013b). Another study suggests that infants follow the gaze of a robot only if they previously saw it have an interaction with an adult (Meltzoff et al., 2010). In summary, infants can identify certain human-like traits in robots, such as gaze, but overall prefer humans (Manzi et al., 2023). Additionally, most studies supporting the social affiliation account of overimitation did so by manipulating the characteristics of the model in the overimitation task (e.g., puppet vs. human; native vs. foreign speaker) but it is not clear if overimitation is linked to a general tendency for in-group preference, which would be a broader, context-free, measure of social affiliation, providing a more conservative test of the social affiliation hypothesis.

Third, we wished to examine if in-group preference was related to overimitation above and beyond its link to other forms of imitation, given that overimitation appears to be particularly driven by social motivations. The final goal was to compare overimitation to other forms of imitation (i.e., elicited imitation and re-enacted unfulfilled intentions imitation). This was achieved by using two classic imitation tasks specifically developed for infants, one designed to assess episodic memory (Bauer and Mandler, 1989), and the other to assess intention understanding (Meltzoff, 1995). Thus, although they are all forms of imitation, overimitation may be a construct distinct from the others due to having a strong social as opposed to a cognitive function. To our knowledge, this is the first study to explicitly measure overimitation in infancy by using a task similar to ones used in older children and to compare it to a separate, direct measure of in-group preference as a proxy for social affiliation.

We hypothesized that (1) performance on the overimitation, elicited imitation, and unfulfilled intentions imitation tasks would be related, but that correlation coefficients would be weaker between the overimitation task and the other two imitation tasks; and (2) although in-group preference would be related to all forms of imitation given the strong social nature of imitation, this link would be stronger with overimitation. In a more exploratory way, we anticipated the participants to show at least some overimitation, and to express preference for the human in the in-group preference task.

Materials and methods

Participants

Participants were recruited from a database of past participants, from local daycares, or from birth lists provided by a governmental health agency. A power analysis using G*Power 3.1.9.7 (3 total predictors and 1 tested predictor; $\alpha = 0.05$; power = 0.80) revealed that the sample had to include at least 55 participants, assuming a medium effect size of $f^2 = 0.15$. Out of the 85 infants who were tested, 12 had to be excluded due to a change in procedures after pilot testing ($n = 10$), and excessive fussiness ($n = 2$). The final sample consisted of 73 participants (32 females, 39 males, 2 identified as other) with a mean age of 18.34 months ($SD = 1.635$; *range* = 16-21 months). An average age of 18 months was targeted because the elicited imitation and unfulfilled intentions imitation tasks were originally developed with this age group. We stopped recruiting participants when we reached our target sample size for all four tasks, as defined by the power analysis.

Responses to a demographic questionnaire indicated that most participants' socioeconomic status were in the upper middle-class, with a median annual family income between $100,000 and $150,000 CAD. The majority of the infants in the sample were identified by their parents as coming from European descent (65.75%). Other ethnic identities reported include Middle Eastern (9.59%), Caribbean (4.11%), African (9.59%), Latin/Central/South American (20.55%), Asian (15.07%), and Indigenous (5.48%). Parents could choose more than one ethnic affiliation, resulting in 41.1% of the sample identifying with two or more ethnicities.

Materials and procedures

All tasks were administered in person in the laboratory. For three of the tasks, infants were seated at a table on a booster seat next to their parent, in front of the experimenter. For the fourth task, infants were seated in a highchair in front of a computer screen with their parent seated behind them. For all tasks, if infants were fussy or uncomfortable, they could sit on their parent's lap with instructions that parental intervention be kept to a minimum.

Prior to the testing session, parents were asked to fill out online a consent form and a demographic questionnaire. Some key elements of the consent form were repeated at the beginning of the testing session, and any question that parents may have had was answered by the experimenter. At the end of the session, infants received a certificate of merit for their participation and the caregivers were offered a $25 gift card from a local bookstore as compensation for their participation. The study was conducted in accordance with the standards of the Declaration of Helsinki. The research was also approved by the appropriate institutional ethics review board.

Four tasks were administered during the testing session, which lasted ∼30 to 45 min, with each task taking between 5 and 10 min to administer. The order of the tasks was counterbalanced across participants to avoid carry-over or fatigue effects. A brief warm-up period (i.e., introducing two plush animals to the infant, similar to the ones used in the in-group preference task) was included at the beginning of the session to familiarize infants with the experimenter and the testing room. The tasks were administered in French or English based on the dominant language of the infant as reported by the parents. Out of the final sample of 73 participants, 34 were tested in French and 39 in English.

Overimitation task

The overimitation task was adapted from Vivanti et al. (2017) and from Hilbrink et al. (2013). Three boxes and three toys (a tiger figurine, a toy truck, and a plush horse), one for each trial, were used for the demonstration of the actions. While each box was placed on the table, the experimenter would say: "Look what I've got! Should I show you how it works?". Infants then watched the experimenter open the box twice following a sequence of three actions. Two of the actions were causally relevant to open the box, while the other one was causally irrelevant. While not exactly the same, these actions are somewhat reminiscent of the functional and arbitrary actions in Óturai et al. (2012, 2013, 2018). The irrelevant actions shown in the current study were thus not related to the mechanisms of the boxes. Table 1 illustrates the objects, boxes, and sequences of actions that were used for each trial.

After the two demonstrations, each box was given to the infant while the experimenter said: "Would you like to play with the box?". There were three trials, and participants were asked to open the box after the two demonstrations for each box. Infants received one point for each irrelevant action performed, resulting in a total score out of three. The order in which the boxes were presented was counterbalanced randomly across participants.

Elicited imitation task

This task was adapted from Chiarella and Poulin-Dubois (2018), based on a task originally developed by Bauer and Mandler (1989) and Bauer and Dow (1994). The materials required for that task included two plastic containers that could fit into each other and a rubber ball (for the Rattle trial), as well as a toy crib, a teddy bear, a blanket, and a pillow (for the Teddy-to-Bed trial). For each trial, infants first had 30 s to interact freely with the objects that were aligned on a tray. Then, the experimenter demonstrated twice a sequence of three actions using the materials, before giving them back to the infant (see Chiarella and Poulin-Dubois, 2018 for a detailed description of the procedures and scoring). For example, for the Teddy-to-Bed trial, the sequence of actions was to (1) put the pillow in the crib, (2) put the teddy bear on the pillow, and (3) put the blanket over the teddy bear. Infants were awarded one point for each action they copied in the correct order, for a maximum of three points per trial. Thus, the maximum score for that task was six. To allow for more variability in the scores, a second scoring

TABLE 1 Materials and modeled actions for the overimitation task.

Box	Toy	Causally relevant action 1	Causally irrelevant action	Causally relevant action 2
		Remove the Velcro	Tap with hand twice on the yellow part	Open the lid
		Push the button	Lift container twice	Remove the lid
		Remove the dowel	Tap top of box twice with the dowel	Open the lid

was also done in which infants were given a point for any action that they reproduced, regardless of the order. The order in which the trials were presented was counterbalanced across participants and randomly assigned.

Unfulfilled intentions imitation task

This task was adapted from Meltzoff (1995). Materials included five object pairs (for five trials): a plastic and wooden dumbbell that could be separated into two sections, a transparent plastic square with a hole in the middle and a wooden dowel, an elastic and a wooden horizontal prong, a plastic stick and a red button embedded in a wooden box that activated a buzzer, as well as an orange plastic cup and a string of beads (see Figure 1). For each trial, all participants first had 20 s to freely interact with an object pair ("Control Baseline" condition of Meltzoff, 1995). Then, the experimenter demonstrated an action three times but failed to complete it on each occasion ("Demonstration of Intention" condition of the re-enactment task; see Meltzoff, 1995 for a complete description of the task). The experimenter then gave each object pair back to the infant. Participants were given one point for completing the target, intended, action on each trial. Thus, a total of five points could be obtained for that task. The order in which the object pairs were presented was randomized across participants.

In-group preference task

This task was adapted from Kinzler et al. (2007) and Kinzler and Spelke (2011). Materials included four pairs of plush animals (i.e., monkey, elephant, cheetah, lion) that were attached to wooden sticks on the back. Infants sat on a highchair or on their parent's lap in front of a computer screen (~27 × 47 cm screen). The screen was positioned on a puppet theater with a black cloth fixed underneath. The cloth had two openings that fell under the screen, on each side of the midpoint. A curtain also hid the infants' view at the top of the computer screen (see Figure 2 for a representation of the set-up for that task).

There were four trials for this task, one for each of the plush toys. For each trial, infants first watched a video of a woman and a robot (i.e., NAO, SoftBank Robotics) showing the same plush animal to the infant. The two agents appeared side by side and performed the actions at the same time. The agents looked at the infant (2 s), held up the toys while looking at the infant (7 s), looked at the toy (5 s), looked back toward the infant (5 s), and then lowered the plush toys to the sound of a bell (1 s; total length of videos = ~23 s). As the plush toys disappeared from the screen, the experimenter, hidden behind the puppet theater, passed the two plush animals that appeared in the video through the two openings under the screen, as if the two agents were offering them to the infant. The two toys were kept motionless for 15 s in front of a still image of the two agents (see Figure 2). If the infant had not touched any of the toys after 15 s, the experimenter gently shook both plush animals simultaneously for another 15 s to prompt the infant to reach for one of them. The same procedure was repeated for each of the animal pairs. In all videos, the woman maintained a neutral expression to match the expression of the robot. An attention getter (a moving star with a bouncing sound; 3 s in length) was shown before each trial to ensure the infant's attention on the task. Infants' first reach (pointing or touching) was scored for each trial. Infants were included on that task if they reached for the toys on at least one of the trials. A score of 1 was given if the first reach was toward the toy offered by the human, and a score of 0 was given if it was toward

FIGURE 1
Materials for the unfulfilled intentions imitation task.

the one offered by the robot, for a maximum score of 4. The order in which the toy animals were presented was counterbalanced across participants. The starting position of the robot and human (left or right) was also counterbalanced across participants, and they switched sides after the second trial. Counterbalancing conditions were assigned randomly to participants.

Demographic questionnaire

Parents also had to fill out a demographic questionnaire, with questions related to occupational status, ethnic origins, family income, health history, and language exposition of the infant.

Scoring and reliability

The testing sessions were recorded and scoring was completed offline by the main experimenter and a coder who was blind to the hypotheses. A subset of the videos (i.e., 25%) was also coded by both scorers. Kappa coefficients indicate excellent interrater reliability for the overimitation task (average of 0.980), the elicited imitation task (weighted kappa coefficient average of 0.980), the unfulfilled intentions imitation task (kappa coefficient average of 0.987), and the in-group preference task (kappa coefficient average of 1.000).

Results

Data analysis

Data analyses were conducted using SPSS 28 (IBM Corp. Released, 2021). Following a visual inspection of the data and using a cut-off z-score of $\pm$ 3.0 (Raykov and Marcoulides, 2008), we identified a few univariate outliers for two of the variables of interest (i.e., scores for one of the overimitation trial and total overimitation score). Although the pattern of results did not change whether these scores were kept in the analyses or not, it was decided to remove these data from the analyses, given that they may introduce some unnecessary variability. We did not identify any multivariate outlier. Normality for individual variables was within recommended skewness (i.e., |3|) and kurtosis (i.e., |10|) values (Kline, 2011), and independence of data points could be assumed given the design. To facilitate comparison between the different tasks, total raw scores were converted into proportion scores. The order of task administration did not affect task performance. Descriptive statistics for each task are presented in Table 2.

FIGURE 2
Set-up for the in-group preference task.

Overimitation task

Of the final sample of 73 infants, one was excluded due to non-engagement in the task, leaving a final sample of 72. One participant was also excluded from the total overimitation score because their score was a univariate outlier. Overall, the sample obtained a mean proportion score of 0.157 (*SD* = 0.203), with 40.8% of the sample ($n = 29$) overimitating on at least one trial. In terms of individual trials, 19.4% of the sample copied the irrelevant action on the transparent box ($M = 0.190$; $SD = 0.399$), 27.8% on the orange box ($M = 0.280$; $SD = 0.451$), and 0% on the red and yellow box. However, before removing the univariate outliers, 8.2% of the sample overimitated on the red and yellow box ($M = 0.080$; $SD = 0.278$). Exact binomial tests indicated that performance on all trials was below chance. The exact Clopper-Pearson 95% CIs for not copying the irrelevant action were (0.695, 0.889) for the transparent box ($p < 0.001$), (0.604, 0.821) for the orange box ($p < 0.001$), and (0.946, 1.000) for the red/yellow box ($p < 0.001$). Chi-square tests also suggested there was no statistically significant association between the performance on the different trials [transparent and orange boxes: $\chi^2_{(1)} = 0.005$, $p = 0.941$; chi-square could not be computed for the red and yellow box].

For exploratory purposes, we also generated a second score for the overimitation task, to account for infants who performed the irrelevant action after the trial had ended, after finding the toy in the box, or who did an action similar to the one demonstrated but not identical enough to originally be included (e.g., shaking the box up and down instead of lifting it). The percentage of infants who copied the irrelevant action on at least one trial using this lenient criterion went up to 70.8% ($n = 51$), with a mean proportion score of 0.347 ($SD = 0.288$). Using this second scoring did not change the pattern of results, so only the results with the original scoring are presented below. We also tried to perform analyses by only including the 32 infants who, before removing the outliers, overimitated on at least one trial ($M = 0.417$), but the conclusions again remain the same. Using an independent-samples

TABLE 2 Descriptive statistics for all tasks.

	Over-imitation	Elicited imitation	Unfulfilled intentions imitation	In-group preference
N	71	72	72	58
Mean (proportion)	0.157	0.391	0.501	0.510
SD	0.203	0.310	0.215	0.341

t-test, performance on the overimitation task did not differ between the infants who preferred the toy offered by the robot and those who chose the toy offered by the human on the in-group preference task [$t_{(56)} = 1.100$, $p = 0.276$, 95% CI (−0.050, 0.173)]. Also for exploratory purposes, we scored the imitation of relevant actions. Inter-rater reliability was very high (κ = 1.000). Mean proportion scores for individual actions ranged from 0.700 to 0.970, with a total mean proportion score of 0.889 (*SD* = 0.145).

Elicited imitation task

Of the final sample of 73 infants, one was excluded due to non-engagement in the task, resulting in a final sample of 72 for that task. Overall, infants obtained an average proportion score of 0.391 (*SD* = 0.310; *M rattle* = 0.542; *M teddy-to-bed* = 0.232). For exploratory purposes, we computed a second score for that task, giving a point for each action copied, regardless of the order. The mean proportion score was 0.706 (*SD* = 0.295; *M rattle* = 0.662; *M teddy-to-bed* = 0.758) with this criterion. This discrepancy with the first scoring might be due to the particularly poor performance on the Teddy-to-Bed trial, as most infants did not put the pillow first in the crib, automatically resulting in a score of 0. This second scoring did account for infants having more difficulty with that trial but given that most other results did not change when using it, we only present the results based on the original scoring (see Supplementary material for results using the second, more lenient, scoring criterion). We also analyzed the data by only using scores from the Rattle trial. None of the other conclusions differed, so scores from both trials were used in further analyses.

Unfulfilled intentions imitation task

Of the final sample of 73 infants, one was excluded for not completing the task, leaving a final sample of 72. The mean proportion score was of 0.501 (*SD* = 0.215). Average scores varied on individual trials, being 0.350 for the plastic square and wooden dowel, 0.440 for the elastic and wooden prong, 0.480 for the dumbbell, 0.520 for the plastic stick and buzzer, and 0.720 for the beads and cup.

In-group preference task

Of the final sample of 73 infants, 15 were excluded due to fussiness, crying, non-completion of the task, choosing no toys or choosing both toys, resulting in a final sample of 58 for that task. On average, infants obtained a proportion score of 0.510 (*SD* = 0.341), meaning that infants reached equally for the toy offered by the human and by the robot across the four trials. It is however important to note that, on average, participants selected a toy on 2.27 out of 4 trials (*SD* = 1.601). A one-sample *t*-test indicated that performance on the in-group preference task was not different from chance [$t_{(57)} = 0.225$, $p = 0.823$]. This was further supported by exact binomial tests and exact Clopper-Pearson 95% CIs. More specifically, 59.5% of the sample preferred the toy cheetah offered by the robot (95% CI of 43.3%−74.4%, $p = 0.280$), 54.8% preferred the toy elephant offered by the robot (95% CI of 38.7%−70.2%, $p = 0.643$), 62.2% preferred the toy lion offered by the human (95% CI of 46.5%−76.2%, $p = 0.136$), and 59.5% preferred the toy monkey offered by the human (95% CI of 42.1%−75.2%, $p = 0.324$).

Overall, 41% ($n = 24$) of the sample expressed a preference for the toy offered by the human, 38% ($n = 22$) for the one offered by the robot, and 21% ($n = 12$) selected both toys equally. Preference was established based on the participant's average proportion score across all completed trials. A score between 0 and 0.49 was coded as preference for the robot, a score between 0.51 and 1 as preference for the human, and a score of 0.5 as an equal preference for both agents.

Inter-task comparisons

We next examined the link between the performance across the different tasks. We first ran bivariate correlations between the total proportion scores on each task. Most scores were not correlated with each other (see Table 3). The only significant correlation was between the elicited and unfulfilled intentions imitation tasks ($r = 0.240$, $p = 0.044$). This might provide support for the hypothesis that overimitation differs from the other two forms of imitation. However, this association did not remain significant after applying the Holm-Bonferroni correction (alpha level set to 0.05) and there was no significant difference between the correlation coefficients on the different imitation tasks (i.e., overimitation, elicited imitation, unfulfilled intentions imitation) using a z test ($z = 0.408$, $p = 0.342$).

TABLE 3 Zero-order correlations between total proportion scores on all tasks.

	Over-imitation	Elicited imitation	Unfulfilled intentions imitation	In-group preference
Overimitation				
r	1	0.017	0.073	−0.124
p (2-tailed)		0.891	0.549	0.353
N		70	70	58
Elicited imitation				
r		1	0.240*	−0.116
p (2-tailed)			0.044	0.385
N			71	58
Unfulfilled intentions imitation				
r			1	−0.154
p (2-tailed)				0.248
N				58
In-group preference				
r				1
p (2-tailed)				
N				

*p < 0.05.

As the sample ranged from 16 to 21 months of age, we also correlated the proportion scores of all tasks with age. Age was only correlated with the elicited imitation task ($r = 0.341$, $p = 0.003$), suggesting that the older infants were, the better they were at imitating sequences of actions demonstrated in the exact order. This association remained significant after applying the Holm-Bonferroni correction (alpha level set to 0.05).

For exploratory purposes, we examined the association between relevant imitation in the overimitation task and the other imitation tasks. There was only a significant correlation between the mean proportion score of relevant actions copied and the elicited imitation score ($r = 0.246$, $p = 0.039$).

Regression analyses

To examine if in-group preference was related to different types of imitation, we ran three linear hierarchical regressions with the main variables of interest. Model 1 included age and Model 2 included the proportion score on the in-group preference task. For each regression, the dependant variable was the total proportion score on the different imitation tasks (i.e., overimitation, elicited imitation, unfulfilled intentions imitation). Overall, both models generated non-significant results except for the elicited imitation task. In that case, Model 1 was significant and explained 15.1% of the variance in the outcome [$F_{(1,56)} = 9.971$, $p = 0.003$, $R^2 = 0.151$, $R^2{}_{adjusted} = 0.136$]. Model 2 was not significant. When looking at the main effects in both models, age was a significant unique contributor to the scores on the elicited imitation task, suggesting that the main effect of age significantly predicted elicited imitation [Model 1: $B = 0.075$, $p = 0.003$, 95% CI (0.028, 0.123); Model 2: $B = 0.074$, $p = 0.003$, 95% CI (0.026, 0.122)]. This again suggests that infants were better at imitating the sequences of actions in the correct order when they were older. None of the other main effects were significant. Overall, then, the hypothesis that social affiliation, as measured with the in-group preference task, drove overimitation performance was not supported.

For exploratory purposes, we ran all the analyses with only the participants who completed all four tasks ($n = 58$). We found a more robust correlation between the scores on the elicited imitation and unfulfilled intentions imitation tasks ($r = 0.374$, $p = 0.004$), but all of our other conclusions remained the same.

Discussion

The main objective of the present study was to compare infants' performance on an overimitation task to performance on two other imitation tasks to determine if they were related to a direct measure of in-group preference, used as a proxy for social affiliation. Overall, we only found, as expected, a link between the elicited imitation and unfulfilled intentions imitation tasks but did not find any other significant associations between task performance and a measure of in-group preference, therefore partly supporting the first but not the second hypothesis.

Considering first individual tasks performance, 29 infants (40.8% of the sample) copied at least one irrelevant action on the overimitation task. As mentioned before, there are currently not many studies in the literature to compare these results to, but the mean proportion score of irrelevant actions in Howard et al.'s (2015) study was 0.57 in their first experiment with 19-month-olds. The current results are however similar to those found in studies by Óturai et al., in which functional and arbitrary actions were modeled with a variety of objects. The mean proportion score for arbitrary actions copied by 18-month-olds was ∼0.167 (Óturai et al., 2012), 0.083 (Óturai et al., 2013), and 0.294 (Óturai et al., 2018). This comparison should however be interpreted with caution, as the 30-min delay in Óturai et al.'s procedures, in which infants engaged in free play, might explain why they found lower scores. Still, the arbitrary actions in these studies are similar in nature to the ones used in the current experiment (e.g., lifting a toy vs. lifting a box) and thus allow for at least some comparison.

It is important to note that the tasks in these studies required two actions (one arbitrary and one functional) to attain a goal using various objects, making it simpler and perhaps easier for infants to imitate all actions. In contrast, the current measure involved a sequence of three actions to open boxes, including one causally irrelevant and two causally relevant, which is similar to some tasks employed with preschoolers (e.g., Dragon and Poulin-Dubois, 2023; Vivanti et al., 2017). Interestingly, 23- and 30-month-old children imitated almost no irrelevant actions in McGuigan and Whiten's (2009) experiment that also used a classic overimitation task with a more elaborate sequence of actions (mean proportion of irrelevant actions copied was 0.16 and 0.18, respectively), which is in line with the current results. Thus, at an early age, it appears that the complexity of the task (e.g., the number of relevant and irrelevant actions in the sequence) has an impact on overimitation performance. It is also important to consider the potential influence of infants' familiarity with the boxes on the low overimitation rate. Although this explanation cannot be excluded, only one box is commercially available for purchase while the other ones were created for the study. Thus, it is unlikely that infants would have had significant previous experience with the stimuli.

Finally, as this is one of the first experiments to study overimitation in infancy and that overimitation becomes more prominent with age (Hoehl et al., 2019), it is also possible that it is not a learning strategy that infants often use yet. In fact, longitudinal results from Óturai et al. (2018) suggest that infants go from mostly imitating selectively (functional actions only) to also imitating exactly (functional and arbitrary actions), with 18 months being a transition period during which infants engage in both selective and exact imitation. Thus, in line with past research, the current results demonstrate that 16- to 21-month-olds engage in at least some overimitation, a skill that might then develop rapidly as children reach the preschool years. Future studies should continue to examine overimitation in very young children to determine what is the earliest age that it reliably develops.

On the elicited imitation task, infants obtained a low average proportion score compared to the original study by Bauer and Mandler (1989) in which 16- and 20-month-olds had mean proportion scores of 0.717 and 0.877, respectively, on the Rattle trial (vs. 0.542 in the current study). The global score seems to be mostly driven by the performance on the Teddy-to-Bed trial. Infants had much more difficulty with this trial compared to the Rattle trial, as many of them did not put the pillow first in the crib. Anecdotally, several parents mentioned that their child was not sleeping with a pillow, so these participants may have not understood the function of a pillow in the sleep scenario, and thus did not deem that object important in the sequence of actions. Additionally, the pillow and the blanket were made from the same fabric and had the same color, so infants may have had trouble distinguishing the two items. Still, the current results are similar to a more recent experiment from which we adapted the procedures, as mean proportion scores were between 0.298 and 0.380 at the age of 18 months (Chiarella and Poulin-Dubois, 2018).

On the unfulfilled intentions imitation task, participants obtained a lower average proportion score than in the original study by Meltzoff (1995), in which 18-month-olds obtained a mean proportion score of 0.80 on the Demonstration of Intentions condition. However, also with 18-month-olds, almost identical results were found by Yott and Poulin-Dubois (2012) (*M proportion score* = 0.55), and lower scores were found by Reschke et al. (2020) (*M proportion score* = 0.36).

Finally, regarding the in-group preference task, infants did not show a preference for the toy offered by the human nor by the robot. Findings appear to be mixed in the literature when testing in-group preference across the characteristics underlying group membership. The original study found that 10-month-old infants showed a preference for the toy offered by the agent that spoke their native language (Kinzler et al., 2007), but Howard et al. (2015) did not with their sample of 19-month-olds. Interestingly, however, Kinzler and Spelke (2011) also did not replicate their findings when using ethnicity. Thus, it is possible that social preference expressed by infants in that task varies depending on the characteristics of the agents. In other words, at such a young age, language might already be a way through which infants identify in-group and out-group members, but not yet race nor animacy as in the present study.

Based on the correlation and regression analyses, only the elicited and unfulfilled intentions imitation tasks were related, as there was a significant correlation only between those scores before applying the Holm-Bonferroni correction. Thus, while not fully supporting the first hypothesis as overimitation may be related to imitation in other studies, these results are, at least partly, in line with it. This suggests that these tasks may have more in common compared to overimitation, possibly because both emphasize the learning component of imitation. Relatedly, given that imitation has two functions (i.e., instrumental and social; Over, 2020; Uzgiris, 1981), some researchers noted that perhaps it is the goal emphasized by children in a situation, depending on the context, that will determine if they imitate (instrumental goal) or overimitate (social goal; Hoehl et al., 2019; Keupp et al., 2018). Thus, although both imitation and overimitation are closely linked to social factors, it might be that overimitation taps more into the social function while simple imitation taps more into the instrumental function, and therefore would explain why they are not related in this study. This argument is further supported by the exploratory finding that the imitation of relevant actions in the overimitation task was correlated with elicited imitation, as these actions are more similar in nature. More research, for example using different imitation tasks or various age groups, should be done to confirm this hypothesis.

The in-group preference task was not associated with any of the imitation tasks, thus refuting the second hypothesis. Various explanations are possible for why we did not find such a link. First, perhaps an effect did not emerge because the rate of overimitation was too low. As mentioned earlier, overimitation research with infants is limited, and tasks of varying complexity have been used, which sometimes measured related concepts rather than overimitation *per se*. A task similar to the ones used with preschoolers was chosen, to allow for a better comparison to the other experiments in the overimitation literature. Most of the sample did not overimitate, and those who did tended to do so on only one of the three trials, which limits possible associations to other tasks or constructs, including in-group preference. Having the arbitrary or irrelevant action in the middle of the sequence might have been too difficult for this age group. Future studies with that age range might benefit from putting it first to promote overimitation. It is worth noting that we made sure infants were attentive to the demonstrations and to use "motionese" (exaggerated movements) which counters the potential argument that infants were not properly encoding the full sequence of actions. Additionally, exploratory analyses revealed that most infants copied the relevant actions. Still, using a different task might be more appropriate for this age group. Perhaps adapting the procedures by having a parent model the actions so that the demonstrator is familiar to the child (Uzgiris, 1981) would boost the overimitation rate. This would also further support the social affiliation account. This is reminiscent of overimitation in dogs, as they have been found to overimitate their owner but not a stranger (Huber et al., 2020), again suggesting a link between overimitation and affiliation. It might also have been difficult for participants to resist immediately getting the toy out of the box, as evidenced by some infants performing the irrelevant action after finding the toy. This may reflect limited executive functioning skills, which is in line with strong inhibitory control limitation in very young children (Diamond, 2013).

Second, there were some methodological limitations with the in-group preference task, most notably that it might not be measuring what we intended it to, that is, it had poor construct validity. Anecdotal reports from several parents indicated that this was the first time their child saw a robot, and responses on the demographic questionnaire indicated that few infants (n = 10) were in contact with any robot (e.g., Roomba vacuum, Alexa). This may suggest that infants identified the robot as an out-group member. The current data do not account for exposure to robots in movies or TV shows, which could be indicative of a familiarity effect. However, it appears more probable that the results might have been confounded by a novelty effect. In fact, given its novelty, the robot might actually have been quite intriguing to infants, who may have chosen the toy it offered because of its attractiveness. Older children imitate and overimitate a robot model equally or less so than a human one (e.g., Schleihauf et al., 2021; Sommer et al., 2020, 2021) and infants do no learn new words from a robot (O'Connell et al., 2009). Still, it might be an agent that infants anthropomorphize (Goldman and Poulin-Dubois, 2024) and want to interact with, such as in studies suggesting that infants attribute false beliefs to inanimate objects (e.g., Burnside et al., 2020), follow the gaze of robots (e.g., Meltzoff et al., 2010; O'Connell et al., 2009), and express similar psychophysiological responses to robot and human gaze (Linnunsalo et al., 2024). Infants might thus perceive humanoid robots as social agents. This might especially be true if they have not yet developed a social preference for humans compared to robots, much like ethnicity, which appears at the end of the preschool years (e.g., Aboud, 2003; Kinzler and Spelke, 2011). Thus, this in-group/out-group distinction with robots and humans may not be clear enough at this age, which is evident in the fact that the average total proportion score on the in-group preference task was not different from chance in the current study. In other words, it may be that no association was found between in-group preference and overimitation because there was no clear preference demonstrated by the sample as a whole. Future research may want to focus on more distinctive and salient in-group characteristics, such as language (Kinzler et al., 2007) and gender (Shutts et al., 2010), or to reduce the animacy of the robot, for example by using a non-humanoid robot, which may decrease the desire to affiliate with it compared to the human.

Moreover, the in-group preference task revealed to be particularly challenging to administer and score, as some infants were scared by the plush animals suddenly appearing in front of them. We thus had to discontinue the task for those participants. Others did not choose a toy at all, rather simply observing. A few infants also reached for both toys at the exact same time, making it impossible to score those trials. For these reasons, it would have been interesting to have a measure of looking time, which would perhaps have detected a clearer preference for one agent over the other. In sum, all these reasons may have affected the construct validity of the in-group preference task and thus made the link between overimitation and in-group preference undetectable.

Another hypothesis for the null results is that perhaps both overimitation and imitation are linked to social affiliation only when it is directly related to the model, but not to a general tendency for in-group preference. Indeed, several studies have found that the characteristics of the model, such as group membership, have a great impact on the tendency of children to imitate and overimitate (e.g., Altinok et al., 2022; Buttelmann et al., 2013; Gruber et al., 2019). Thus, it may be that social affiliation has to be directed at the model to influence the rate of imitation and overimitation. Finally, the lack of association between tasks may also simply be due to the age of the sample. Perhaps it is only later in life, after children have had more opportunities to interact socially and create relationships, that they may start giving more importance to overimitation and social affiliation. This is consistent with previous research showing a developmental shift, in that younger infants focus on cognitive motivations to promote instrumental learning whereas older infants also consider social motivations to initiate and maintain interactions (Nielsen, 2006; Óturai et al., 2012, 2018; Uzgiris, 1981). Imitative behavior then changes, from being selective by copying only relevant actions to more faithful and also copying irrelevant ones.

In conclusion, the goal of this research was to study overimitation in infancy, and to compare it to other forms of imitation, as well as to a measure of in-group preference as a proxy for social affiliation. Results revealed a significant association between the elicited imitation and unfulfilled intentions imitation tasks, but none between overimitation or imitation and in-group preference. Future research should continue to study overimitation in younger children, as research is still scarce in that age group. It should also further explore the link between overimitation, imitation, and social affiliation, both in infancy and in older children. Understanding how children learn from others, even at a young age, is essential in helping us optimize children's learning experiences.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/x4tj5/?view_only=8e70b49e665b4b7b9fe53cb6456178e5.

Ethics statement

The studies involving humans were approved by Concordia University Human Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s) for the publication of any identifiable images or data included in this article.

Author contributions

MD: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. DP-D: Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The author(s) declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fdpys.2025.1559513/full#supplementary-material

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