



Sensitivity to Confidence Cues Increases during the Second Year of Life

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We investigated the emergence in infancy of a preference to imitate individuals who display confidence over lack of confidence. Eighteen- and 24-month-olds ($N = 70$) were presented with an experimenter who demonstrated the use of several objects accompanied by either nonverbal expressions of confidence or lack of confidence. At 24 months, infants were more likely to imitate the actions when demonstrated by a confident experimenter than by an unconfident experimenter; 18-month-olds showed no such preference. The experimenter then presented an additional imitation trial and a word-learning trial while displaying a neutral expression. Twenty-four-month-olds persisted in preferentially imitating a previously confident experimenter, but prior confidence had no effect on their word learning. These findings demonstrate a developmental increase in infants' use of confidence cues toward the end of the second year of life.

Infants frequently imitate others' actions, but they do not imitate indiscriminately. For instance, infants in the second year of life prefer to imitate intentional rather than accidental actions (Carpenter, Akhtar, & Tomasello, 1998; Olineck & Poulin-Dubois, 2005) and attend to physical constraints or causality (e.g., Brugger, Lariviere, Mumme, & Bushnell, 2007; Gergely, Bekkering, & Király, 2002). Here, we investigate whether infants modulate their imitation as a function of a model's expressed confidence.

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Selective learning has been extensively investigated in preschool-age children: They can use a variety of cues including age, reliability, and confidence to moderate their social learning (see Mills, 2013 for a review). However, only recently has research investigated model-based selective social learning at or before 2 years of age (see Harris & Lane, in press, for a review). Infants can be sensitive to individuals' accuracy or reliability: For instance, 16-month-olds protest when someone provides incorrect labels for objects (Pea, 1982) and look longer at an individual who engages in incorrect labeling acts (Koenig & Echols, 2003). As early as 18 months, children are more likely to learn and retain novel labels taught by a previously accurate, rather than inaccurate, labeler (Brooker & Poulin-Dubois, 2013; Koenig & Woodward, 2010). Fourteen- to 16-month-olds attend to individuals' emotional reliability (Chow, Poulin-Dubois, & Lewis, 2008; Poulin-Dubois, Brooker, & Polonia, 2011; Poulin-Dubois & Chow, 2009) and conventionality of actions (Zmyj, Buttelmann, Carpenter, & Daum, 2010). Even at 12 months, infants display greater social referencing toward a more competent experimenter and subsequently use that experimenter's emotional displays to guide their own behavior toward a toy (Stenberg, 2013). Infants' imitation is also biased by the model's age (Zmyj, Aschersleben, Prinz & Daum, 2012; Zmyj, Daum, Prinz, Nielsen & Aschersleben, 2012), ingroup membership (Buttelmann, Zmyj, Daum, & Carpenter, 2013), and situational expertise (Stenberg, 2009, 2012).

One model-based cue to reliability that has received relatively little attention is confidence. Preschool-age children are known to attend to verbal expressions of confidence (e.g., "I know" versus "I guess"; Jaswal & Malone, 2007; Sabbagh & Baldwin, 2001; Stock, Graham, & Chambers, 2009), and one series of experiments demonstrated that 2-year-olds (mean age of 30 months) preferentially imitate someone showing nonverbal cues of confidence over several action demonstrations (Birch, Akmal, & Frampton, 2010). The only study that has manipulated confidence in infancy demonstrated that 14-month-olds are more likely to imitate an individual having previously demonstrated *both* competence and confidence over one having demonstrated *both* lack of confidence and inaccuracy simultaneously (Zmyj et al., 2010). However, that study was primarily designed to test whether 14-month-olds imitate differentially based on a model's competence and not to test whether infants are sensitive to *confidence* cues specifically. Hence, the 2-year-olds in Birch et al. (2010) are the youngest age group so far to have demonstrated a preference to learn from more confident individuals, with no additional cues of competence.

We aimed to investigate the emergence of the effect of a model's confidence on imitation during the second year of life: At what age do toddlers

begin to demonstrate a preference to imitate an individual showing cues of confidence over one showing a lack of confidence? Given that the youngest group so far to have this ability were 2-year-olds (with a mean age of 30 months), we decided to test the emergence of this understanding in children who just passed their second birthday (24-month-olds) as well as 6 months earlier (18-month-olds), allowing to test developmental changes in infants' use of confidence cues between 18 and 24 months. Confidence (or lack thereof) can be expressed with many types of cues, including linguistic cues (e.g., "I am not sure") and nonverbal cues present in facial expressions or body language (e.g., shrugging, palms up). Given that linguistic abilities are highly variable at the ages we tested and that this variability could influence children's ability to process linguistic confidence cues, we chose to solely present nonverbal cues (similar to cues presented in Birch et al., 2010, and Zmyj et al., 2010).

Confidence can be used in two ways, as a situational cue to someone's certainty and also as an indicator of an enduring trait. Infants could use an individual's show of confidence during a specific action demonstration to determine whether or not the model is certain about *that action* and whether the action should be imitated; in addition, they could use a model's history of confidence or hesitancy over a series of actions to infer that individual's *enduring* competence and use this inferred trait to moderate their imitation of subsequent actions demonstrated neutrally. We decided to examine both of these possible uses of confidence in 18- and 24-month-olds.

METHOD

Participants

Seventy typically-developing children were recruited from families living in a large metropolitan area. We tested thirty-six 18-month-olds (17 months 26 days–19 months 17 days; $M = 18$ months 20 days; 20 females) and thirty-four 24-month-olds (24 months 0 day–25 months 10 days; $M = 24$ months 19 days; 18 females). Families represented a range of socioeconomic, ethnic, and linguistic backgrounds. Participants were tested in either English ($N = 34$) or French ($N = 36$) by a bilingual experimenter, depending on the infant's dominant language.

Design

The experimental session consisted of two phases: A first phase consisting of trials where the experimenter showed either confidence or lack thereof (hereafter "Cued" phase) followed by a phase during which the

experimenter acted neutrally (hereafter “Uncued” phase). The Cued phase included two blocks of three imitation trials: “familiar objects” and “novel objects” trials. The order of the two blocks was counterbalanced. The Uncued phase included two trials (order counterbalanced): Head Touch Imitation and Word Learning. Model confidence in the Cued phase was manipulated between-subjects: Half of the participants witnessed a confident model, and half witnessed an unconfident model.

Materials

Materials are pictured in Figure 1. “Familiar objects” imitation trials used a hair brush, a bowl with spoon, and a toy car. “Novel objects” imitation trials included a set of interlocking colorful wooden blocks, a cylindrical wooden rattle, and a roll of rope. The Uncued imitation trial involved a touch light mounted on a black cardboard box. The Uncued word-learning trial included two unfamiliar objects (a plastic bathtub drain cover and a part of a clothing pin), a small bowl and a tray.



Figure 1 Materials. First row: Familiar objects in Cued Phase. Second row: Novel objects in Cued Phase. Third row: Mounted light for Head Touch, objects and tray for Word Learning.

Procedure

The same female experimenter tested all children. After a warm-up session in a playroom, children entered the testing room and sat at a table facing the experimenter. Most ($N = 50$) sat in a high chair with a parent sitting behind; the remaining children sat on their parent's lap during at least part of the experimental session. Parents were instructed not to give children any hints or instructions during the testing session. As many children naturally turned to their parent during the experiment, parents were told that they could smile at their child but not say anything, and, if their child handed them an object, that they should take it and put it back in front of their child. The testing sessions were videotaped for off-line coding.

Cued phase

On each trial, the experimenter picked up an object from a box and put it on the table in front of her, then either confidently or unconfidently performed an action. Actions with the three familiar objects included the experimenter brushing her hair with the hairbrush, putting the spoon in the bowl and bringing it to her mouth while making eating sounds, and rolling the car back and forth. Actions with the three novel objects included spinning the arc-shaped wooden block on the interlocking blocks object, putting the cylindrical rattle upright on the table and spinning it, and bending the roll of rope into a u-shape. As the familiar actions were known to infants, we expected that expressions of confidence would have little impact on infants' imitation of these actions but a greater impact on novel action imitation. The experimenter ensured the child was attentive during the action demonstrations; on the few occasions where a child got distracted, the experimenter paused her demonstration, attracted the child's attention by calling his or her name and resumed when the child looked again toward her.

For children in the *confident* condition, the experimenter began each trial by picking the relevant object from a box next to her and putting it on the table in front of her. She looked at the child, said "Aha!" with a raised index finger and satisfied facial expression (see Figure 2), then lifted and inspected the object while nodding and saying "Hmm-hmm!" with a satisfied tone of voice. She then repeated the same sequence three times: looking at the child, saying "Hmm-hmm!" while nodding and making a satisfied expression, and performing the relevant action on the object. After three repetitions, she put the object down, crossed her arms, looked at the child with a smile and a satisfied expression, nodded and said "Hmm-hmm!". She finally handed the object to the child, smiled and said: "Now it's your turn! Can you play with it?"



Figure 2 Example of confidence cues (left) and unconfidence cues (right).

In the *unconfident* condition, the sequence of actions was similar except for the vocal and nonverbal expressions. After putting the object in front of her, the experimenter frowned and raised her finger to her chin and said “Hmmm...”. She picked up the object, looked at it with a confused facial expression, looked at the child, then shrugged her shoulders with raised palms and a confused facial expression, saying “Huh!” (See Figure 2). She then repeated the same sequence three times: looking at the child while raising palms and shrugging shoulders, saying “Huh!” and performing the relevant action on the object. After three repetitions, she put the object down, raised her shoulders and palms once more, made a confused facial expression and said “Huh!”. She then handed the object to the child as in the *confident* condition (note that the experimenter smiled encouragingly in both conditions when handing the object to participants so that they did not believe that any negative affect was directed toward them).

After handing the object, the experimenter waited until the participant imitated the action or 30 seconds elapsed, then took the object away and continued with the next trial. Each trial lasted approximately 1 minute in total, including the confidence or unconfidence cues, three repetitions of the action demonstration, and imitation phase. Participants’ actions were subsequently coded for imitation attempts. Infants were scored as imitating if they put the hairbrush to their own head; put the spoon in the bowl and in or near their own mouth; rolled the car back and forth; grabbed or pushed the arc-shaped interlocking block; put the rattle upright on the table; and bent the roll of rope.

Uncued phase

Participants then completed an additional imitation trial (Head Touch) and a Word-Learning trial. There was one trial of each type, and although

they were always administered after the Cued phase, the order of these two trials within the Uncued phase was counterbalanced across participants. On both trials, the experimenter demonstrated all actions with a neutral to mildly positive expression regardless of her previous (un)confidence. The Head Touch trial was modeled after Meltzoff (1988). The experimenter placed a mounted touch light on the table, looked at the participant, said "Look!", then bent her head and turned the light on with her forehead. She then repeated "Look!" and bent again, turning the light off with her forehead. She then pushed the light toward the participant, saying "Now it's your turn!" and waited 30 seconds or until the participant attempted to turn the light on with his/her head.

The Word-Learning trial was adapted from Woodward, Markman, and Fitzsimmons (1994). Children were shown two unfamiliar objects in a fixed order. The target object (whether it was the first or second object was counterbalanced between children) was labeled three times with a novel label (e.g., Look, a toma! It's a toma! Look, a toma!) while the distracter object was referred to without any label (e.g., Look at this one! Look at that! Look at this one!). This sequence was repeated three times. Both objects were then placed on a tray on either side of a bowl (side counterbalanced). The experimenter repeated five times a request to put "the *toma* in the bowl" while raising the tray above her head, lowering it toward the table and finally pushing it toward the participant. Two scores were computed: First Touch and Object Selection. On First Touch, infants scored as correct if they first touched the target object and incorrect if they first touched the distracter. On Object Selection, infants scored as correct if they put the target object in the bowl first and incorrect if they put the distracter in the bowl first. Infants were prompted if they did not respond immediately; if infants selected both objects simultaneously, the trial was repeated up to twice.

All videotaped testing sessions were coded by the same primary coder. Eighteen videos (26%) were additionally coded for reliability. Raters agreed on 96% of familiar object trials, 100% of both novel object trials and Uncued imitation trials, and 92% of Uncued word-learning trials. Discrepancies were resolved by reviewing the relevant videotapes.

RESULTS

Cued phase

Results are summarized in Table 1. An Object Type (Familiar versus Novel) \times Confidence (Confident versus Unconfident) \times Order (Familiar first versus Novel first) \times Age (18 versus 24 months) mixed ANOVA

TABLE 1
Results by Age Group and Condition

Age	Condition	Cued trials (/6)		Cued trials (Familiar: /3)		Cued trials (Novel: /3)		Head Touch: N touch with head/Total N	Word learning: N first touch target/Total N	Word learning: N select target/Total N
		Mean	SD	Mean	SD	Mean	SD			
18 months	Confident	4.11	1.49	2.28	.89	1.83	1.04	12/18	13/17	8/15
	Unconfident	3.94	1.35	2.11	1.02	1.83	.71	15/18	10/18	13/18
24 months	Confident	4.82	1.38	2.47	.87	2.35	.93	16/17	12/17	9/16
	Unconfident	3.06	1.75	1.41	1.00	1.65	1.00	10/17	8/15	6/15

revealed a main effect of Confidence, $F(1,62) = 6.96$, $p = .011$, and a significant interaction between Confidence and Age, $F(1,62) = 4.78$, $p = .033$. There was also an unexpected significant interaction between Age, Object Type and Order, $F(1,62) = 2.50$, $p = .046$. This last interaction indicated a “warm-up” effect in 18-month-olds, who showed greater imitation on whichever trial block was presented second. This effect was not of theoretical interest and therefore was not investigated further. There were no other significant main effects or interactions. Note that, contrary to our expectations, there was no significant interaction between Object Type and Confidence, $F(1,62) = .96$, $p = .331$, *ns*, indicating that the model’s confidence did not differentially affect imitation of familiar and novel actions.

Planned independent-samples *t*-tests separating age groups showed that 18-month-olds equally imitated a confident or unconfident model, $t(34) = .35$, *ns*. This was also true when examining familiar and novel actions separately (familiar: $t(34) = .52$, *ns*; novel: $t(34) = .00$, *ns*). In contrast, 24-month-olds imitated more actions from a confident than unconfident model, $t(32) = 3.27$, $p = .003$. This was true for both familiar and novel actions (familiar: $t(32) = 3.28$, $p = .003$; novel: $t(32) = 2.13$, $p = .041$). Because of the 18-month-olds’ greater overall imitation during the second block, we additionally tested the effect of confidence on each age group’s imitation rate during the second block only. Once again, 18-month-olds did not differ in their imitation of a confident ($M = 2.17$) or hesitant model ($M = 2.33$; $t(34) = -.62$, *ns*), but 24-month-olds imitated more actions from a confident ($M = 2.35$) than hesitant model ($M = 1.53$; $t(32) = 2.66$, $p = .012$).

On the majority of trials, infants manipulated the test objects even if they did not imitate the actions (e.g., by pushing, picking up, or otherwise fiddling with the object). It was very rare that an infant would not engage with an object at all; this only occurred in five infants for a total of 19 trials. We repeated our analyses after removing these trials; this did not change the pattern of results (i.e., 18-month-olds still failed to moderate their imitation based on the model’s confidence, $t(34) = .95$, *ns*, while 24-month-olds did, $t(31) = 3.01$, $p = .005$).

Uncued phase

In 24-month-olds, there were more head touch actions in the *confident* than in the *unconfident* condition (Fisher’s exact $p = .039$, two-tailed). In contrast, 18-month-olds imitated equally in both conditions (Fisher’s exact $p = .443$, *ns*). Although most children engaged with the light even if they did not imitate the head touch action, one 24-month-old did not touch the light at all. The value of the Fisher’s exact test for 24-month-olds did not

change after removing that child. As a manipulation check to ensure that findings on this trial were not due to any inadvertent confidence cues by the experimenter on what was supposed to be a neutral trial, her expression, voice, and gestures were rated for 28 participants (40% of the sample) by a coder who was not involved in the study and was blind to the participants' condition and their rate of imitation in the Cued phase. This coder only ever used two of the points on a 5-point scale ("Hesitant", "Mildly Hesitant", "Neutral", "Mildly Confident", "Confident") in her ratings of the experimenter's demonstrations, indicating that the experimenter's actions were remarkably constant across participants; additionally, the minor differences in apparent confidence observed by the coder were uncorrelated with the participant's condition, $r(28) = .07$, *ns*, or their previous imitation, $r(28) = -.23$, *ns*.

On the word-learning task, one 18-month-old and two 24-month-olds had no First Touch score because of ambiguous or no response. Of the remaining 34 infants in the *confident* condition, 25 selected the target object (binomial $p = .009$); of the 33 infants in the *unconfident* condition, 17 selected the target object (binomial $p = .720$, two-tailed). The difference between conditions was, however, not significant by Fisher's exact test, either with both age groups combined ($p = .131$, *ns*) or when separating age groups (both $ps > .20$). Six infants (three in each age group) did not have an Object Selection score because they either refused to put either object in the bowl or consistently put both objects at the same time even after repeating the trial. Of the remaining 31 infants in the *confident* condition, 17 first put the target object in the bowl (binomial $p = .720$, two-tailed); of the 33 infants in the *unconfident* condition, 19 first put the target object in the bowl (binomial $p = .487$, two-tailed). The difference between conditions was nonsignificant by Fisher's exact test ($p = 1.00$, *ns*) and was not significant either when separating age groups (both $ps > .30$).

DISCUSSION

This study is the first to examine whether a preference to imitate more confident individuals is present in infancy. We found that, at 24 months, infants prefer to imitate both familiar and novel actions demonstrated confidently rather than unconfidently, but that no such preference exists at 18 months. Furthermore, after repeatedly witnessing an individual's confidence or lack of confidence, 24-month-olds (but not 18-month-olds) continue to prefer imitating a previously confident individual on a subsequent action demonstrated neutrally, but did not transfer this preferential learning to a word-learning situation.

Hence, 24-month-olds can use confidence as a situational cue, preferring to imitate *actions* demonstrated confidently than unconfidently. Indeed, the fact that 24-month-olds were equally likely to moderate their imitation of actions with familiar and novel objects based on confidence suggests that confidence expressions of a model have a powerful effect on infants of that age when deciding what action to perform in a specific context, and not just to moderate their learning of novel actions. For example, when infants saw the experimenter show hesitancy for a hair-brushing action, their subsequent reluctance to imitate the action did not stem from not knowing the function of a hairbrush; rather, they likely interpreted the individual's hesitancy as context-specific uncertainty. These are striking findings given that infants of that age are highly familiar with the functions of these objects and even tend to overimitate at that age (Nielsen, 2006).

In addition, 24-month-olds can use confidence as an *enduring* cue, showing some continued preference to imitate a previously confident individual over a previously unconfident one even on a subsequent action demonstrated with a neutral expression. There was, however, no clear evidence that this preference transfers to a word-learning situation. Note that, although toddlers in past studies have shown high rates of success on this type of word-learning task in the second year of life (Woodward et al., 1994), in the present study, this trial was presented after multiple (arguably much more interesting) imitation trials, resulting in increased fatigue and possibly reducing the rate of success. With only one trial of each type in the Uncued phase, one cannot make strong claims about the breadth of toddlers' generalization of an individual's confidence across different types of learning situations. In preschoolers, there is conflicting evidence about how broadly children generalize reliability cues such as past accuracy, with some studies finding some generalization across different types of learning situations (e.g., Koenig & Harris, 2005; Koenig & Jaswal, 2011) and others finding limited or absent generalization in younger preschoolers (Brosseau-Liard & Birch, 2010). This question has not yet been explored with the cue of confidence. It furthermore remains unclear at this point how otherwise robust or enduring the effect of prior confidence would (or should) be on subsequent learning and imitation. Although recent studies on early selective learning have convincingly demonstrated that infants can use an individual's prior actions to moderate their subsequent learning from that individual (Chow et al., 2008; Zmyj et al., 2010), one might argue that confidence is a cue of a different nature and that an increase (or decrease) in an individual's expression of confidence is an important indicator that the individual is more (or less) competent in the new situation. Future work could investigate this question further.

In contrast, 18-month-olds showed no sign of moderating their rate of imitation based on a model's demonstrated confidence or hesitancy. The high overall rate of imitation in 18-month-olds rules out inattention or lack of interest as explanations for this lack of effect. Anecdotally, children in both age groups were very attentive to the cues demonstrated by the experimenter and frequently reacted with either laughter, facial expressions of discomfort, or even imitation of the confidence or hesitancy displays; yet, only the older age group used confidence cues to moderate their imitation. Thus, a preference to imitate actions demonstrated confidently becomes more apparent between 18 and 24 months.

Future research could attempt to investigate what accounts for this developmental progression. It is possible that 18-month-olds, and even younger infants, do possess some understanding of confidence cues but do not use this understanding because their social motivation to imitate is not as strong as in older children (Nielsen, 2006). The present developmental pattern is consistent with recent literature showing developmental changes in children's motivation for imitation during the second year of life. It has been argued that imitation serves two complementary functions: a cognitive function that promotes learning and a social function that promotes social engagement (Over & Carpenter, 2013; Uzgiris, 1981). The social motivation for imitating others has been shown to increase during the second year of life, as shown by the fact that 24-month-olds are more likely than 12-month-olds or 18-month-olds to imitate (rather than emulate) a model (Nielsen, 2006). They are also less likely to imitate when the opportunity for spontaneous contingent interaction is removed, like when the model is videotaped (Nielsen, Simcock, & Jenkins, 2008). In the present context, indications of lack of confidence might have reduced the social motivation to imitate due to a lack of identification with the model or a deficit in "like me" understanding (Meltzoff, 2007).

A second possibility for the observed developmental effect is that an understanding of the meaning of confidence cues is not yet present at 18 months and develops by 24 months. Much younger children react to the valence of facial and emotional expressions and moderate their imitation based on such cues (Carpenter et al., 1998; Chow et al., 2008; Stenberg, 2009, 2012). It may be that confidence expressions are relatively difficult to understand, at least compared with other emotional cues or communicative gestures, and that social interaction during the latter part of the second year of life allows infants to develop a better understanding of these specific social cues. There is also a strong possibility that this emergence is related to the development of children's understanding of the meaning behind the conventional gestures indicating confidence or uncertainty. There is important development in the use of conventional gestures

(e.g., waving good-bye or shaking one's head to say no) in the second year of life (e.g., Camaioni, Aureli, Bellagamba, & Fogel, 2003; Guidetti, 2002; Thal & Tobias, 1992), and the little data available specifically on toddlers' production of gestures such as shrugging shoulders to indicate uncertainty suggest that these are produced relatively infrequently in very young children (Acredolo & Goodwyn, 1988; Guidetti, 2002). To our knowledge, there is little research specifically examining the time line of infants' *understanding* of the meaning of specific gestures, but, given the increase in toddlers' overall communicative abilities between 18 and 24 months, it is likely that an increased understanding of the meaning behind certain culture-specific gestures contributes to the greater use of confidence cues.

Although our results clearly demonstrate that 24-month-olds can modulate their imitation based on individuals' confidence cues, this of course does not imply that they would do so in all possible situations. For instance, it is possible that if a model was demonstrating inaccurate or unconventional actions (e.g., attempting to eat with a hairbrush), children would refuse to imitate those actions or subsequent novel actions regardless of the model's confidence. Conversely, it is possible that, while 18-month-olds do not show any sign of moderating their imitation based on a model's confidence in the present study, they would do so in different circumstances. For example, perhaps 18-month-olds would be more likely to use confidence cues when deciding whether to imitate an action that is clearly unconventional or wrong. To date, there are only a few published studies testing children's ability to weigh different knowledge or competence cues in the preschool period (Brosseau-Liard & Birch, 2011; Jaswal & Neely, 2006; Pillow & Weed, 1997), and, to our knowledge, none yet in the infancy period. Future studies could explore this interaction between cues of confidence and competence on young children's imitation.

In conclusion, the present study demonstrates a developmental increase in the preference to imitate more confident individuals' actions between the ages of 18 and 24 months. This is the youngest age group to have been studied on the impact that model confidence, unconfounded with any other cues, has on social learning. This work thus provides an important addition to the growing literature on selective social learning in infancy and early childhood.

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