

The Development of Imitation in Infancy: Is the Ability Present at Birth?

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Introduction

The ability to imitate other people is one of the most important mechanisms through which infants learn. By watching and reproducing another person's actions, children can acquire motor skills, learn how objects are used, participate in social routines, and begin to understand the intentions of people around them. Imitation also supports communication before children can speak fluently. A baby who copies a gesture, sound, or action is not only reproducing movement but may also be joining a social exchange.

Despite the importance of imitation, psychologists continue to debate when this ability begins. Some researchers have argued that newborn babies can imitate facial expressions and hand movements within the first weeks of life. According to this position, human beings may be born with a specialized mechanism that allows them to match another person's visible actions with movements of their own body. This proposal has influenced developmental psychology, neuroscience, theories of mirror neurons, artificial intelligence, and social robotics.

Other researchers question whether newborn behaviour should be described as genuine imitation. They argue that infants' matching movements may result from arousal, reflexive responses, spontaneous motor activity, feeding-related movements, or the general effects of seeing an interesting stimulus. From this perspective, mature imitation does not appear as a complete, inherited ability at birth. It develops gradually through the interaction of perception, motor experience, memory, attention, social engagement, and learning.

The current evidence does not justify a simple conclusion that infants either possess imitation fully at birth or acquire it suddenly at one later age. Instead, imitation appears to include several abilities that develop at different rates. Newborns may sometimes match particular facial movements, especially tongue protrusion, but researchers disagree about whether these responses represent flexible imitation. During the first two years, however, children clearly become increasingly capable of reproducing actions, remembering demonstrations, selecting which actions to copy, and using imitation for social and practical purposes.

This essay examines the major theories and evidence concerning the origins of imitation. It compares the nativist explanation, which proposes that imitation is present from birth, with developmental and dynamic-systems accounts, which view imitation as an emerging skill. It argues that imitation is best understood not as a single inborn module but as a collection of abilities that develop through the

continuing interaction of biological preparedness, motor development, experience, and social relationships.

What Is Imitation?

Imitation occurs when a person observes another individual's behaviour and produces a corresponding action. This definition sounds simple, but determining whether a baby is genuinely imitating can be difficult.

Suppose an adult sticks out their tongue and a newborn then protrudes its tongue. The behaviours match, but the match alone does not establish imitation. The newborn might have copied the adult intentionally. However, the movement might also have occurred because the adult's face increased the baby's general excitement, because tongue protrusion is common in newborns, or because the visual stimulus triggered an oral response.

Researchers must therefore distinguish imitation from several related processes.

Mimicry usually refers to an automatic or relatively unconscious matching of another person's movements or expressions. Emulation occurs when a learner reproduces the result of another person's behaviour without copying the precise action used to achieve it. Stimulus enhancement occurs when another person draws attention to an object, increasing the likelihood that the observer will interact with it. Response facilitation occurs when seeing an action increases the likelihood of a similar movement already available in the observer's behavioural repertoire.

Genuine imitation should ideally involve a reliable relationship between a specific modelled action and the infant's corresponding response. If a baby protrudes its tongue after every interesting display, the response cannot confidently be interpreted as imitation. The baby should produce more tongue protrusions after observing tongue protrusion than after observing mouth opening, finger movement, or a non-social control stimulus.

This requirement illustrates why imitation research needs carefully designed comparison conditions. Observing that an infant's action resembles an adult's behaviour is not enough. Researchers must demonstrate that the infant responds selectively to the particular action shown.

Why Imitation Matters for Child Development

Imitation contributes to several areas of development. It allows children to acquire information without discovering everything through trial and error. A child can watch an adult open a container, use a spoon, operate a toy, wave goodbye, or complete a household routine and then attempt the same behaviour.

Imitation also supports the development of memory. When an infant reproduces an action after the model is no longer present, the child must retain some representation of the observed event. This process, known as deferred imitation, provides researchers with a way to study memory before children can describe past experiences verbally.

Socially, imitation can create connection. Adults often copy babies' facial expressions, sounds, and movements during playful exchanges. These interactions may help infants recognize that another person is attending and responding to them. Longitudinal evidence suggests that being imitated by sensitive caregivers may contribute to the development of infants' later imitative abilities, supporting the view that imitation grows partly through reciprocal interaction rather than unfolding independently of experience (Essler et al., 2023).

Imitation is also connected to language and social engagement. A longitudinal study of children between 12 and 24 months found that imitation skills increased during the second year and that growth in imitation was related to expressive language and social engagement (Young et al., 2011).

These findings explain why the origins of imitation matter. If babies imitate from birth, then a sophisticated perception-action matching system may be present before substantial learning occurs. If imitation emerges later, social and motor experience may play a much larger role in constructing the ability.

The Nativist Account of Neonatal Imitation

The nativist account proposes that humans enter the world with a biologically prepared ability to connect observed actions with movements of their own bodies. This position became highly influential after Andrew Meltzoff and M. Keith Moore published a landmark study in 1977.

Meltzoff and Moore tested infants between 12 and 21 days old. They reported that the infants reproduced facial and manual gestures, including tongue protrusion, mouth opening, lip protrusion, and finger movements. The researchers concluded that the infants could match actions they saw with actions of their own bodies, even though babies cannot directly see their own faces (Meltzoff & Moore, 1977).

This finding challenged earlier developmental theories. Jean Piaget had proposed that imitation emerged gradually as infants learned to coordinate perception and action. If babies only a few weeks old could imitate unfamiliar facial gestures, then imitation appeared to begin much earlier than previously believed.

Meltzoff and Moore later proposed the active intermodal mapping account. According to this explanation, infants possess a system that represents observed and performed actions in a shared form. A baby can see an adult's tongue movement and compare it with information received from moving their own tongue. Through repeated attempts, the infant may adjust the movement until it

more closely matches the observed model.

Other studies subsequently reported neonatal matching of facial expressions, head movements, and finger gestures. Some researchers interpreted these results as evidence that infants are born ready to engage socially and recognize similarities between themselves and other people.

The nativist account does not necessarily claim that imitation remains unchanged after birth. Experience can refine the ability. Nevertheless, it proposes that the essential perception-action matching mechanism is already available in the neonatal period.

Neonatal Imitation and the Mirror-System Hypothesis

Reports of newborn imitation later became connected to theories of mirror neurons. Mirror neurons were initially identified in the motor areas of monkeys. These neurons responded both when the animal performed an action and when it observed another individual performing a similar action.

Researchers proposed that humans might possess a broader neural mirroring system that connects action observation with action execution. Such a system could potentially contribute to imitation, action understanding, empathy, language, and social cognition.

If newborns imitate before they have accumulated substantial visual and motor experience, neonatal imitation might be evidence that the mirroring system is at least partly inherited. Some researchers have therefore described newborn imitation as support for an inborn neurological mechanism that allows infants to translate observed behaviour into matching movement.

However, this interpretation goes beyond what behavioural evidence alone can demonstrate. A matching gesture does not reveal which neural mechanism produced it. Furthermore, non-invasive measures used with infants, such as electroencephalographic mu-rhythm changes, provide indirect evidence of action-observation processes rather than direct recordings of individual mirror neurons.

The mirror-system hypothesis remains useful for studying links between seeing and performing actions, but it should not be treated as definitive proof that newborns possess a fully developed imitation module. Neural systems themselves can change through experience. A biological capacity for rapid learning may therefore exist even if the detailed connections underlying imitation are not complete at birth.

Challenges to the Evidence for Newborn Imitation

Although the original neonatal imitation findings became widely known, many laboratories struggled to reproduce them consistently. Some studies found matching for tongue protrusion but not for other

facial or manual gestures. Others found no reliable evidence of selective imitation.

This inconsistency led researchers to question whether newborn imitation was a general ability or whether the effect depended on particular procedures, gestures, samples, and scoring decisions.

The most substantial challenge came from a longitudinal study by Oostenbroek and colleagues (2016). The researchers tested 106 infants at one, three, six, and nine weeks of age. The babies observed nine social actions and two non-social control conditions. The study found that infants were no more likely to produce a particular gesture after seeing the corresponding model than after seeing other actions. The authors concluded that the results did not provide compelling evidence for neonatal imitation (Oostenbroek et al., 2016).

This study was important because it used a larger sample, tested multiple gestures, included control conditions, and followed the same infants over time. Its findings suggested that earlier positive results might have reflected small samples, selective measures, or spontaneous infant behaviour rather than a general imitative capacity.

Supporters of neonatal imitation disputed this conclusion. Meltzoff and colleagues reanalysed the data and argued that the design had reduced the likelihood of detecting imitation. Their reanalysis reported evidence that infants produced more tongue protrusions after observing tongue protrusion, although it did not establish equally strong imitation across the full range of actions (Meltzoff et al., 2018).

The disagreement shows that neonatal imitation is not a settled fact. Researchers disagree not only about the results but also about which experimental procedures provide a fair test.

What the Meta-Analytic Evidence Shows

Davis and colleagues (2021) conducted a meta-analysis of 336 effect sizes from 33 independent samples. Their analysis found an overall positive effect for neonatal imitation. However, the results differed substantially across studies, and the variation was associated with researcher affiliation.

The authors offered two broad interpretations. Neonatal imitation may be real but highly sensitive to methodological conditions that researchers have not yet identified. Alternatively, the overall positive effect may partly reflect analytical flexibility, publication patterns, or differences among research groups rather than a reliable neonatal capacity (Davis et al., 2021).

The meta-analysis therefore did not end the controversy. It showed that the published literature contains positive evidence, but it also raised serious questions about reliability and reproducibility.

A careful conclusion is that some newborns under some conditions produce movements matching those of adult models. The stronger claim—that newborns possess a flexible, general-purpose ability to imitate a wide range of actions—has not been established consistently.

Why Tongue Protrusion Is Difficult to Interpret

Tongue protrusion is the most frequently reported neonatal imitation response. It is also the action for which positive findings have been most consistent. However, this apparent strength creates an interpretive problem.

Tongue movements are common in newborns because they are involved in feeding, oral exploration, and early sensorimotor development. A baby may protrude the tongue in response to visual stimulation, excitement, or the presence of a face without copying the exact action.

If newborns imitate only tongue protrusion but not mouth opening, facial expressions, hand gestures, or head movements, the behaviour may reflect a specific oral response rather than a broad imitation system.

Researchers therefore need comparison conditions. A newborn should produce significantly more tongue protrusion after seeing tongue protrusion than after seeing alternative gestures. Even when this difference occurs, researchers must consider whether the adult's action increased arousal or activated feeding-related behaviour.

The tongue-protrusion debate demonstrates a central principle of developmental research: matching behaviour can have several possible causes. Interpretation must be based on patterns across controlled conditions, not on a single resemblance between infant and adult actions.

The Dynamic-Systems Account

A dynamic-systems account offers an alternative to the idea of an inherited imitation module. It proposes that imitation emerges from interactions among many developing abilities rather than from one specialized mechanism.

These interacting components include:

- visual attention;
- control of the head, face, hands, and body;
- memory for observed events;
- knowledge of the body;
- motivation to engage with others;
- experience of being imitated;
- understanding of goals;
- familiarity with objects;
- language development; and
- the social context in which an action occurs.

Under this account, an infant's behaviour changes as the entire developmental system changes. Improved sitting and reaching alter what the child can observe and reproduce. Repeated interaction with caregivers creates associations between seen and performed movements. Memory development allows actions to be reproduced after longer delays. Growing social awareness helps infants understand why another person is acting.

Imitation is therefore not expected to appear fully formed at one moment. Different types of imitation should emerge at different ages because they depend on different combinations of skills.

For example, copying a simple hand movement requires control of the hand and attention to the model. Reproducing a three-step action on an unfamiliar object also requires memory, sequencing, and object understanding. Copying an unusual action only when it appears purposeful requires the infant to interpret the model's constraints and intentions.

This account fits evidence that imitation becomes more varied, accurate, selective, and socially meaningful across the first two years.

Learning Through Perception and Motor Experience

Infants gain extensive experience connecting perception and action. They watch their hands move, feel their muscles produce movement, hear the sounds created by their actions, and observe caregivers responding to them.

Through repeated experience, infants can learn associations between seeing and performing actions. When a caregiver waves while moving the infant's hand, or copies the baby's sounds and expressions, visual, auditory, and motor events occur together. These experiences may gradually establish links that later support imitation.

Active motor experience is particularly important. Children understand actions partly through performing them. An infant who has learned to grasp, reach, crawl, or manipulate an object has richer information for interpreting similar behaviour in others.

This does not mean that development begins from nothing. Newborns possess sensory preferences, motor patterns, learning mechanisms, and strong orientation toward faces and voices. The dynamic account proposes that evolution may have equipped infants to learn imitation efficiently without providing a complete library of action-matching rules at birth.

Biological preparation and learning are therefore not mutually exclusive. The infant may be biologically prepared to attend to people, learn associations, and coordinate perception with movement. Social experience then organizes these abilities into increasingly flexible imitation.

The Development of Deferred Imitation and Memory

Deferred imitation occurs when a child observes an action and reproduces it after a delay. Because the model is no longer performing the action, deferred imitation provides evidence that the child formed and retained a memory.

Meltzoff (1988) demonstrated that nine-month-old infants could reproduce simple actions involving unfamiliar objects after a delay. In another study, 14-month-old infants imitated novel actions after one week, even though they had not been allowed to handle the objects during the original demonstration (Meltzoff, 1988a, 1988b).

These studies show that imitation during later infancy is more than an immediate reflexive response. Infants can encode another person's behaviour, store information about it, and use that information later.

Deferred imitation becomes stronger as memory, attention, and motor planning improve. Younger infants generally retain fewer actions, require shorter delays, and depend more heavily on similarity between the original and test contexts. Older infants can remember longer sequences and reproduce them in somewhat different settings.

Imitation therefore offers a window into cognitive development. It shows not only whether children can copy but also what they remember, how they organize events, and whether they can transfer learning to new situations.

Selective and Rational Imitation

Children do not copy everything they see. During the second year, imitation becomes increasingly selective. Infants consider the apparent goal of an action, the efficiency of the method, the social relationship with the model, and the constraints of the situation.

Gergely, Bekkering, and Király (2002) demonstrated this process using 14-month-old infants. An adult switched on a light by touching it with her forehead. In one condition, her hands were visible and free. In another, her hands were occupied.

Infants were more likely to copy the unusual head action when the adult's hands were free. When her hands were occupied, they tended to use the simpler method of switching on the light with their hands. The researchers described this as "a selective, interpretative process" rather than mechanical copying (Gergely et al., 2002, p. 755).

The infants appeared to reason that when the adult's hands were unavailable, using the head was

necessary only for her particular circumstances. When her hands were free, the unusual action seemed intentional and therefore worth copying.

Longitudinal research has also shown changes between 12 and 15 months in selective and faithful imitation. Infants' copying depends partly on the causal structure of an action and partly on growing social motivation (Hilbrink et al., 2013).

These findings demonstrate that developed imitation is not a simple visual-motor reflex. It involves interpretation. Infants increasingly ask, in behavioural terms, what the actor is trying to accomplish and why that particular movement was selected.

Imitation as Social Communication

Imitation does more than transfer practical skills. It also communicates attention, similarity, and affiliation.

When caregivers imitate an infant, the baby receives evidence that their actions are being noticed. Repeated exchanges of sounds, smiles, and movements can create a conversational rhythm before language develops.

Infants also appear sensitive to imitation between other individuals. Studies with infants younger than six months found that they expected an imitator to approach or affiliate with the individual being imitated. This suggests that babies recognize imitation as socially meaningful before they become highly skilled imitators themselves (Powell & Spelke, 2018).

Interactive demonstrations may also support learning more effectively than detached observation. Research indicates that younger infants may imitate novel actions more successfully when the demonstration occurs within a responsive social exchange rather than as an impersonal display (Matheson et al., 2013).

The social function of imitation helps explain why caregiver sensitivity matters. Children are not simply cameras recording movement. They learn within relationships. Eye contact, timing, emotional expression, turn-taking, and responsiveness can influence which actions attract attention and are remembered.

A Developmental Timeline of Imitation

The following table summarizes broad patterns rather than fixed milestones. Children develop at different rates, and performance depends on the action and testing conditions.

Approximate age	Imitative or related ability	Important qualification
Birth to 2 months	Some studies report matching of tongue, mouth, facial, or hand movements	Evidence is inconsistent, and the interpretation as flexible imitation remains disputed
4 to 6 months	Infants recognize imitation as socially meaningful when observing interactions	Recognizing imitation does not necessarily mean producing it accurately
Around 9 months	Infants can reproduce some simple object-directed actions immediately or after a delay	Performance depends on memory, motor skill, familiarity, and context
12 to 15 months	Imitation becomes more selective, socially motivated, and sensitive to action goals	Infants may copy the result, the method, or both, depending on the situation
12 to 24 months	Imitation improves substantially and becomes connected with language and social engagement	Different children and different action types follow different developmental paths

The table shows why imitation should not be described as one unitary ability. A newborn's possible tongue matching, a nine-month-old's reproduction of an object action, and a 14-month-old's interpretation of an adult's intention are not psychologically identical achievements.

Methodological Problems in Infant-Imitation Research

Studying infants presents unusual difficulties. Babies cannot follow verbal instructions, explain their intentions, or complete long testing sessions. Their alertness changes rapidly, and hunger, fatigue, discomfort, or distraction can affect behaviour.

Researchers must decide which movements count as responses, how long to observe the infant, how to establish a baseline, and which control actions to use. Small changes in these decisions can influence results.

Several methodological problems are especially important.

Small Samples

Many early studies included relatively few infants. Small samples produce unstable estimates and increase the likelihood that chance differences will appear meaningful.

Multiple Behaviours and Comparisons

Researchers may measure many possible infant movements after several modelled actions. Unless analyses are planned carefully, the probability of finding at least one apparently significant match increases.

Observer Bias

If coders know which action the infant observed, their expectations may influence how ambiguous movements are classified. Video coders should therefore be unaware of the experimental condition whenever possible.

Inadequate Controls

Comparing behaviour only with the infant's baseline may be insufficient. A modelled action might increase general activity rather than produce specific imitation. Researchers should compare the target response across several gesture conditions.

State of the Infant

A newborn's behaviour depends heavily on alertness, feeding, and arousal. Studies that test infants in different states may obtain different results.

Selective Publication

Positive findings are often more likely to be published than unsuccessful replications. This can make the literature appear more consistent than the full body of research actually is.

These issues do not show that neonatal imitation is impossible. They explain why confident conclusions require large samples, transparent procedures, preregistered analyses, appropriate controls, and independent replication.

Evaluating the Nativist and Developmental Accounts

The nativist account explains why some infants appear to match adult actions very early. It also emphasizes that infants are socially responsive from the beginning of life and may possess biological systems that connect perception and action.

However, the account has difficulty explaining inconsistent replication, the prominence of tongue protrusion relative to other gestures, and the substantial development of imitation throughout infancy.

A developmental or dynamic-systems account explains why different forms of imitation appear at different times and why motor experience, memory, caregiver interaction, and social motivation influence performance. It also accommodates individual differences and changes between 12 and 24 months.

The dynamic account does not require the conclusion that the infant mind is entirely unstructured. Newborns are biologically prepared to attend to faces, voices, movement, and social contingency. They can learn rapidly and possess motor systems that generate a range of behaviours.

The key disagreement concerns what is inherited. Nativist theories propose that a specialized matching mechanism is functional from birth. Developmental theories propose that infants inherit broader learning and social-attentional capacities from which flexible imitation is constructed.

Current findings favour caution toward the strongest nativist claim. The evidence does not consistently show that newborns can flexibly imitate a range of facial, manual, and vocal actions. Evidence is much stronger that imitation develops and expands across the first two years through the interaction of biological, cognitive, motor, and social factors.

Implications for Parents and Educators

The scientific debate does not require parents to test whether newborns can copy specific facial expressions. The practical lesson is that responsive interaction supports development.

Caregivers can encourage learning by:

- facing the baby during play;
- responding to sounds and gestures;
- imitating the child occasionally;
- allowing time for the infant to respond;
- demonstrating simple actions with objects;

- repeating routines;
- naming actions and objects;
- using expressive but not overwhelming gestures; and
- providing safe opportunities for exploration.

Children should not be pressured to copy on command. A baby may understand an action without immediately reproducing it. Motor limitations, temperament, interest, fatigue, and unfamiliarity can all influence visible performance.

Parents should also avoid treating one failed imitation task as evidence of a developmental disorder. Developmental assessment must consider a broad range of communication, motor, cognitive, and social behaviours over time.

Conclusion

Imitation is one of the foundations of human learning, but its developmental origin remains more complicated than early accounts suggested. Classic studies reported that infants only a few weeks old could reproduce facial and manual gestures. These findings inspired theories of an inborn imitation system and were later linked to claims about an inherited mirror-neuron mechanism.

Subsequent research, however, has produced inconsistent results. The largest longitudinal study of neonatal imitation found no reliable copying across nine modelled actions, while later reanalysis identified possible evidence for tongue protrusion. A broad meta-analysis found an overall positive effect but also substantial variation associated with research groups and unresolved methodological factors.

The evidence therefore does not support treating flexible neonatal imitation as an unquestioned fact. Newborn matching may occur in limited circumstances, but it is difficult to distinguish from spontaneous movements, arousal, oral reflexes, and response facilitation.

Evidence is much clearer that imitation develops substantially during infancy. By later in the first year, infants can reproduce object-directed actions and remember demonstrations. During the second year, they imitate more accurately, retain actions for longer periods, consider the goals and constraints of the model, and use imitation as part of social communication.

The most convincing explanation is that imitation is not one inherited and fully formed module. It is a developing family of abilities. Biological preparedness gives infants the capacity to attend to people, control movement, and learn from repeated experience. Social relationships, motor development, attention, and memory then shape these capacities into flexible imitation.

Human beings may therefore be born prepared to become imitators without necessarily being born as complete imitators. The development of imitation reflects both nature and experience: an active

infant body and brain learning within a responsive social world.

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