Imitation by Animals: How Do They Do It?

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Abstract

Imitation is of psychological interest in part because it has cognitive implications for how organisms view the behavior of others, relative to their own behavior. It implies the ability to take the perspective of another. For this reason, researchers have tried to distinguish imitation from other kinds of social learning and influence. In the two-action procedure, one of two response topographies is demonstrated, and the correlation between the topography demonstrated and the topography later used by the observer is a measure of imitation. Both pigeons and Japanese quail show response matching, despite the fact that from their perspective, their own behavior appears quite different from that demonstrated. Although imitation has been demonstrated in birds and several species of primates, researchers are still not certain what mechanisms underlie this ability.

Keywords

imitation; social learning; two-action procedure; bidirectional control procedure

Imitation, the copying of an otherwise improbable response, plays a critical role in the life of the developing child. Although it is not difficult to be convinced of the adaptive value of imitation, identifying the mechanism responsible for imitation remains quite speculative. Biologists and psychologists look at this question quite differently. To a biologist, whether animals can learn from observing the behavior of others is a question of adaptive advantage. Biologists have focused primarily on genetically predisposed behavior that is triggered by internal and environmental events. Although genetically predisposed behavior would have the advantage of being reliable, it also would have the disadvantage of being relatively inflexible. Should there be a rapid change in the environment, the process of natural selection might not be rapid enough to select genes appropriate for survival.

The most obvious alternative to genetically predisposed behavior is individual learning. Individual learning provides a level of flexibility that does not require the genetic predisposition to match the nature of the environment in which the individual will have to survive. But individual learning has the disadvantage that it may require the learner to encounter the perhaps fatal consequences of errors made while learning (e.g., while learning where to find food, an animal may encounter a predator). To the biologist, social learning (the ability to learn from others) provides a useful intermediate step between genetic predispositions and individual trial-and-error learning, maintaining much of the flexibility of individual learning, while reducing the likelihood of possible aversive consequences associated with making errors.
THE MECHANISM OF IMITATION

To a psychologist, however, the question is not so much how social learning benefits the animal, but rather by what mechanism information is socially transmitted. To a psychologist, there are various kinds of social learning, the most interesting of which is imitation—and especially a form of imitation in which the imitated response is perceptually opaque to the observer (Heyes & Ray, 2000). Perceptually opaque responses are those for which, from the perspective of the organism that enacts the behavior, there is little perceptual similarity between this action and the same action when it is performed by another organism (e.g., putting one’s hand on one’s head). The psychological question is one of correspondence. Assuming that the observer is motivated to imitate a demonstrated behavior, how does the observer know when its own behavior matches that behavior? Piaget (1962) proposed that the problem of correspondence can be solved in humans by the ability of the observer to take the perspective of the demonstrator.2

Alternatively, R.W. Mitchell (2002) suggested that the ability of organisms to match cross-modally (specifically, kinesthetic-visual matching) allows them to solve the problem of correspondence. According to Mitchell, the ability to match one’s (personally) unseen behavior to the similar behavior produced by a demonstrator results from experience. The felt and seen parts of one’s own body match the seen parts of the body of another, allowing one to infer that the felt but unseen parts of one’s own body are similar to the seen parts of the other’s.

In either case, if perceptually opaque imitation requires such relatively sophisticated cognitive abilities, finding imitation in animals would have important implications for the generality of those cognitive processes. However, when asking whether animals show evidence of imitation, one needs first to distinguish imitation from other, perhaps simpler, mechanisms that might be responsible for behavioral matching.

Alternatives to Imitation

Several mechanisms that would not be considered imitation may contribute to behavioral matching by animals, and if one is attempting to find evidence for imitation in animals, these should be identified and controlled.

- **Contagion.** Contagious behavior can be defined as behavior that is automatically triggered, or released, by the similar behavior of others (in humans, yawning and laughing are contagious behavior). Contagion typically applies to reflexive behavior that occurs in the presence of the performing demonstrator and does not require learning. Researchers who study imitation in animals can generally avoid this reflexive behavioral similarity by using an arbitrary target behavior and by interposing a delay between when the behavior is demonstrated and when the observer’s performance is assessed.

- **Mere presence.** An increase in a target behavior may be attributed to the mere presence of the demonstrator (a phenomenon sometimes referred to as social facilitation). If the presence of another animal increases the general arousal of the observer, it is possible that the frequency of the target behavior (e.g., bar pressing, in experiments with rats) will increase as well. Researchers can easily control for mere presence by including a control condition involving observation of an animal that does not demonstrate the target behavior.

- **Stimulus enhancement.** If the target behavior involves manipulation of an object (e.g., bar pressing), the movement of that object (independent of the behavior of the demonstrator) may be sufficient to draw the observer’s attention to it, thus increasing the likelihood that the observer will approach and manipulate the object. This mechanism, often called stimulus enhancement, poses special procedural challenges if it is to be distinguished from imitation.

- **Learned affordances.** Finally, the sequence of events observed, rather than the method of producing those events, may be the basis for the observer’s learning. Observing a performing demonstrator may lead an observer to learn how the environment works (developmental psychologists refer to this as learning the affordances of the task, or observational conditioning). For example, a young child who is shown the top being removed from a capped pen may be more likely to remove the cap than a control child who is merely shown the pen. However, one might see the same increase in cap removal if the child saw the cap being removed without actually seeing a demonstrator remove it.

By a process of elimination, we can identify the critical aspect of imitation, and a more sharply defined definition of imitation emerges: For an action to qualify as imitation, the observer must learn the specific response topography (i.e., the specific action by which the response is made).

The Two-Action Procedure

The two-action procedure can be used to control for each of the alternatives to imitation that I have described. This procedure involves two experimental groups that differ only in the topography of the response
demonstrated. The question addressed is whether each observer will tend to use the response topography that it has observed, rather than the alternative response topography observed by the other group. If so, imitation is indicated. Such evidence for imitation has been reported for both pigeons and Japanese quail observing a conspecific either stepping on a treadle or pecking at a treadle to obtain reinforcement (Akins & Zentall, 1996; Zentall, Sutton, & Sherburne, 1996; see the former article for a schematic of the apparatus). When quail observers that had seen a pecking demonstrator were given access to the treadle, 92% of their responses to the treadle matched those of the demonstrator; among observers that had instead seen a stepping demonstrator, 80% of their responses to the treadle matched those of the demonstrator.

Is the Behavior Perceptually Opaque?

To what extent are pecking at and stepping on a treadle perceptually opaque? Although a bird may be able to see its own beak, the visual stimulus of its own beak while pecking is certainly quite different from the visual stimulus of the demonstrator’s beak while it is pecking. Similarly, although at certain times it is possible for a bird to see its own feet, it cannot do so while it is stepping on the treadle because when the bird is in a stepping or walking position, its head is directly above its body, and its protruding chest prevents the bird from seeing its feet. Thus, in neither case does the stimulus provided by the sight of a demonstrator pecking or stepping resemble the stimulus provided to the observer by its own pecking or stepping behavior.

Demonstrator Reinforcement

If imitation occurs at a reflexive level, one might expect that the consequences of the demonstrator’s behavior (to the demonstrator) would not be an important factor in whether the observer imitates the behavior. If, however, imitation involves more cognitive processes, observed consequences to the demonstrator might have an effect on the probability that the observer will imitate. Akins and I found that when Japanese quail were given access to a treadle after being exposed to a demonstrator that received reinforcement (i.e., food) for pecking or stepping on it, most of the observers’ responses matched those of their demonstrator. However, when the demonstrators received no reinforcement for pecking at or stepping on the treadle, the observers did not imitate the target behavior (Akins & Zentall, 1998).

Observer Motivation

In humans, imitation is likely to depend on the motivation of the observer to attend to the behavior of the demonstrator. For example, someone who is interested in learning how to drive a motorcycle is more likely to learn how to do this through imitation than is someone who has no interest in learning how to operate a motorcycle. Might motivation be important to imitation in animals as well? If an animal observes another animal performing a task for which food is the reinforcer, will the observer be more likely to imitate if it is hungry than if it is not? In fact, Dorrance and I have found that Japanese quail will not imitate if they are not hungry during the period of observation (Dorrance & Zentall, 2001).

Deferred Imitation

I suggested earlier (see also Bandura, 1969) that evidence for imitation is more convincing if the period of observation is separated in time from the period during which the observer’s performance is assessed. Bandura proposed that such deferred imitation rules out the possibility that the observer’s response to the behavior of the demonstrator is reflexive and suggested that the observer must have formed a cognitive representation of the demonstrated behavior that could be accessed later. In all of the experiments with pigeons and Japanese quail that I have summarized thus far, the periods of observation and observer performance were separated by a brief interval (perhaps 1 min). Dorrance and I demonstrated, however, that Japanese quail will imitate even when the period of observer performance is deferred by as long as 30 min from the time of observation—a period certainly long enough for the observer’s behavior to qualify as deferred imitation (Dorrance & Zentall, 2001).

The Bidirectional Control Procedure

An interesting variant of the two-action procedure is the bidirectional control procedure (e.g., Heyes & Dawson, 1990), in which demonstrators are trained to push an object in one of two directions. Following observation of one of the demonstrators, the observer is reinforced for pushing the object in either direction. Heyes and Dawson reported that observer rats tended to push an overhead pole in the same direction that they had seen it pushed.

My co-workers and I have found similar matching of the direction of the demonstrated push using a screen that could be pushed either to the left or to the right to gain access to food (Akins, Klein, & Zentall, 2002). In this experiment, we extended Heyes and Dawson’s (1990) design by controlling for learned affordances. To accomplish this, we included two control groups of quail that also observed a demonstrator gaining access to food, but for these groups the screen was in-
visibly pushed to the left or to the right by the experimenter, rather than overtly pushed by the demonstrator. We found that quail in the experimental groups pushed the screen in the direction that was demonstrated, whereas those in the control groups did not.

Another consideration in interpreting the results of the bidirectional control experiments with rats is that the observers may have been able to detect the side on which a demonstrator had pushed by the residual odor of the demonstrator on one side of the pole. If the observers smelled the pole at the location that the demonstrator pushed it, fortuitous reinforced pole pushes may have occurred. Attraction to the odor left on the pole where it was pushed may have resulted in inadvertent pole pushes by observers, and as a result of the reinforcement that followed, the observers might have continued to push that side of the pole, all in the absence of imitation (C.J. Mitchell, Heyes, Gardner, & Dawson, 1999).

In a recent experiment using the screen-push procedure with pigeon rather than rat subjects, Klein and I found that pigeons showed a significant tendency to match the direction of screen push demonstrated to them by another pigeon. In contrast, the pigeons did not imitate the direction of screen pushes when there was another pigeon present but the screen was pushed by the experimenter. Furthermore, when observer pigeons were prevented from seeing the screen pushes of the pigeon demonstrator (an odor control condition), they did not match the direction of screen pushes (Klein & Zentall, in press).

CONCLUSIONS

There is now considerable evidence that in addition to humans and the great apes (Custance, Whiten, & Bard, 1995), birds (pigeons and Japanese quail) can imitate perceptually opaque behavior. The behavior appears to be true imitation because it has been demonstrated under conditions that rule out alternative accounts. It is not likely, however, that kinesthetic-visual matching learned through experience is the mechanism underlying imitation in birds, because birds probably do not have the kind of kinesthetic matching experiences that are presumed by R.W. Mitchell (2002) to be responsible for such learned correspondence.

Alternatively, the perceptual systems of some animals may function cross-modally such that a visual image of the behavior of a demonstrator may automatically stimulate kinesthetic centers involved in the same behavior when performed by the observer. Recent research with monkeys demonstrated that certain neurons that were activated when a monkey performed a grasping action were also activated when the monkey observed a human perform a grasping action (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996). Although the discovery of these specialized mirror neurons is exciting, it should be noted that in this case the behavioral correspondence was relatively transparent because there was visual similarity between the grasping action produced by the monkey itself and that produced by the experimenter. A critical question is whether mirror neurons will prove to be responsible for imitation in animals even under more opaque conditions. Even more important is the question of whether these mirror neurons belong to “prewired” neural pathways that evolved to facilitate imitation or have to be trained to behave the way they do. If learning is required, mirror neurons may result from imitation rather than be its cause.

Thus, the major question that remains is, what mechanisms underlie animals’ ability to imitate? As this is not an easily answered question, it may be more functional to ask some more tractable ones. For example, humans are able to imitate a sequence of responses (e.g., how to change batteries in a flashlight). Can animals show such an advanced form of imitation? Also, why has it been relatively easy to demonstrate imitation in bird species but relatively hard to find any evidence for imitation in nonprimate mammals? The attempt to answer such questions should help researchers understand this perplexingly complex behavior.

Recommended Reading


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Notes

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2. The imitation of facial gestures by newborns (Meltzoff & Moore, 1989) might appear to be inconsistent with the hypothesis that such perspective taking is learned through experience, but it is likely that this is a special case in which certain responses associated with feeding (e.g., tongue protrusion and mouth opening) are biologically predisposed to occur in response to similar facial expressions by an adult.
Movies About Intelligence: The Limitations of g

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Abstract

There is a strong tendency for the same people to do better or worse on a wide variety of IQ tests. On this basis, some psychologists posit the concept of g, or a general intelligence factor. Does g show that performance on a wide range of cognitive tasks is influenced by individual differences in brain quality? It may, but if so, g lacks a sociological dimension and cannot explain cognitive trends over time or assess their significance. It also encourages a paradox about nature versus nurture and oversimplifies the causes of the Black-White IQ gap.

Keywords

g; intelligence; IQ gains; race

cognitively complex task than scrambling eggs and therefore has a higher g loading. Jensen believes he knows why g influences cognitive performance: “Some property (or properties) of the brain . . . has cognitive manifestations that result in the emergence of g” (Jensen, 2002, p. 153). In other words, Jensen believes that g measures the influence of brain quality. And a better brain gives you an advantage in school, on the job, wherever cognitive skills are relevant.

The g we calculate by the techniques available today may not be a pure measure of brain quality; that is, it may be diluted by picking up the influence of nonphysiological factors like individual differences in motivation. However, throughout this article, I pretend that Jensen’s ideal of a purely physiological g has been realized. I do this in order to show that the closer we approach that ideal, the more g suffers from a peculiar limitation: It becomes sociologically blind. The symptoms are most evident when we take a look at the evolution of cognitive skills over time.

g CANNOT DETECT SOCIOLOGICAL FACTORS

Since 1950, the populations of The Netherlands, Belgium, Israel,