Perspectives on Imitation: From Neuroscience to Social Science

Volume 1: Mechanisms of Imitation and Imitation in Animals

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primates have very precise control of voluntary m.ovement in specific areas,
such as visual-manual   coordination,   and yet lack precise imitative skills in
those same areas. If their movements   were governed   entirely by ideomotor
principles,   then their imitative skills should reflect the precision of their
actions and perceptions   in various domains, but they do not. For example,
apes can visually parse many subtle human gestures and respond to them
appropriately,   but they cannot reproduce those gestures, despite having
sufficient motor control to do so.

The same criticism applies to the theory of "mirror" neurons. To a de-
gree, mirror neurons behave as if they were components   of ideomotor
maps, and their" existence seems to bolster the likelihood that ideomotor
theory will prove useful in explaining some aspects of voluntary move-
ment. However, the presence of mirror neurons does not guarantee the ex-
istence of imitative skills in a species. Monkeys have mirror neuron systems
and learn to make excellent predictions about the consequences of their
actions, but are nevertheless very poor at imitation. Imitation is different.
Its explanation will nof entail a simple extrapolation of a universal princi-
ple of movement control. In human evolution, the refinement of imitative
skill has been linked to the emergence of mimetic gesture, role-playing, so-
cial transmission,   and skilled rehearsal; in a word, to the intensification   of
social life, nonverbal communication,   and group coordination.

8.8   How to Analyze learning   by Imitation
Bennett Galef on Heyes

For me, the most interesting feature of Heyes's associative-sequence learn-
ing model of imitation is not that it predicts that the ability to imitate
will be experience dependent or that imitative learning is simply the pro-
duction of novel sequences of familiar acts, controversial though those
notions may be. Rather, my attention is captured by the assertion that
the ability to imitate rests entirely on processes that are not unique to
imitation itself. It is here that the contrast with theories, such as Melt-
zoff's active intermodal matching model (Meltzoff & Moore, 1999a), that
postulate a dedicated, innate mechanism for .imitation that transforms
visual input into representations encoding modeled movements, is most
pronounced.

The implications of Heyes's approach are quite profound. If, as Heyes
proposes, imitation results from the formation of horizontal links among
visual representations and vertical links between sensory and motor repre-
sentations, such general processes may be better studied in nonimitative

than in imitative situations, where they may be confounded. To the extent Heyes is correct, imitation becomes an epiphenomenon reflecting the activity of basic processes with functions other than support of imitative learning that can be studied without reference to imitation. For example, in Heyes's view, as I understand it, studies of the effects of practice on learning motor sequences would inform our understanding of imitation, much as studies of rhyming skills and sensitivity to phonemes inform our understanding of reading (Bradley & Bryant, 1983; Bryant et al., 1990). Imitation, like reading, can be viewed as an emergent property of mechanisms evolved for other purposes (Gould & Vrba, 1982).

The second point that I would like to make is that identifying the general substrate of imitation, whether behavioral or neuronanatomical, may be a hopeless task. As Heyes, and others, have indicated repeatedly, the most convincing evidence of imitative behavior in nonhuman animals is found in chimpanzees and birds (Heyes, 2002; vol. I, ch. 6). Despite decades of effort by numerous investigators (e.g., Visalberghi & Fragaszy, 2002), there is only the most limited evidence of imitative learning in monkeys (Voelkl & Huber, 2000) and none in rodents (c. Mitchell et al., 1999). Birds imitate (e.g., Akins & Zentall, 1998; Moore, 1992), chimpanzees imitate, and humans imitate. Probably dolphins (Herman, 2002) and orangutans (Russon & Galdikas, 1993; \Tan Schaik & Knott, 2001) imitate as well. This unusual phylogenetic pattern suggests that the behavioral phenomena we conventionally label as imitative are products of convergent evolution rather than of descent from a common ancestor (Moore, 1992). If so, there is no reason to expect the same behavioral or physiological substrates to underlie imitation in all imitative species.

Compare imitation by quails, chimps, and humans, as described in the literature. A quail may show an increased probability of using one of two simple responses, say pecking at and stepping on a treadle, after seeing a model use one method rather than the other to obtain food (e.g., Akins & Zentall, 1998). A chimp, after extensive training may learn, marginally, to follow a do-as-I-do command (e.g., Tomasello et al., 1993b) Of, when manipulating a complex object, will sometimes copy a demonstrator's actions with greater or lesser fidelity (e.g., Whiten, vol. I, ch. 11). A human adult can, without special training, closely imitate a near-infinite number of acts after seeing them but once.

Are such differences in performance quantitative or qualitative? We don't know. Still, we describe chimps, quails, and humans as "imitators," although quite different processes may support their imitative learning. Many models of imitation learning may be correct. Different models may

simply describe substrates of imitation on different branches of the phylo-genetic tree or at different points in development.

8.9   The Imitative Correspondence   Problem: Solved or Sidestepped?
Andrew Whiten on Heyes

Among the interesting and important contributions to imitation research described in Cecilia Heyes's chapter, two stand out. First is the associative sequence learning (ASL) model for the fundamental causal processes un-derlying imitation, particularly for what Nehaniv and Dautenhahn (2002a) have called the correspondence problem. This problem-of how the sen-sory input generated in observing another's action becomes translated into motor output that will produce a recognizably similar action by the imitator-is arguably the central scientific puzzle in imitation research. So far the field has little to offer as a solution to how imitators manage this almost magical-appearing trick, so principled hypotheses such as that offered by Heyes deserve our critical attention.

   Second, Heyes outlines a suite of experimental studies that, along with those by Zentall that she cites, appear at last to provide convincing evi-dence for imitation of a quite sophisticated character in birds. Given how elusive such demonstrations have proved in the course of a century's efforts (Whiten & Ham, 1992) this is an increasingly satisfying body of empirical results to have put before us.

   The difficulties I perceive in the ASL model, however, seem to be sharpest when these two contributions are juxtaposed. For example, can the ASL model really explain the achievements of the budgerigars in Heyes and Saggerson's experiments when they copy use of a foot rather than the beak to solve the artificial foraging task set them?

   The essence of the ASL model is that (1) ("vertical") associations are built up, by one or more special kinds of experience, between actions observed in others and corresponding actions by oneself; and (2) ("horizontal") associations among sequences of observed actions can be translated into corresponding sequences of actions performed by oneself. Accordingly, imitation can be learned "from scratch" by associative processes widely available in the animal kingdom.

   Heyes outlines several possibilities for the special experiences necessary to build the vertical associations, or correspondences. Whether imitation can indeed be acquired by these associations remains to be empirically tested, but for several there appear to be inherent difficulties, especially