
*Social Learning
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*Imitation in Animals:
History, Definition, and
Interpretation of Data
from the Psychological Laboratory*

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INTRODUCTION

Since the latter part of the 19th century, scientists have discussed the possibility that animals are capable of learning by imitation. Darwin (1871) explained difficulties in poisoning or trapping wild animals as the result of their ability "to learn caution by seeing their brethren trapped or poisoned" (p. 49). Wallace (1870) interpreted consistency from generation to generation in the structure of the nests of birds of the same species as the result of young observing and imitating the nest of their parents. Romanes (1884) treated imitation learning and subsequent biological inheritance of imitated behaviors as responsible for both continuity across generations in species-typical patterns of behavior and the perfection of instincts. During the early part of the present century, many of the major figures in the early history of experimental psychology (Hobhouse, 1901; Kohler, 1925; Lashley, 1913; McDougall, 1924; Morgan, 1900; Thorndike, 1911; Watson, 1908), as well as any number of less well remembered behavioral scientists, studied and speculated about the process of imitation learning (Berry, 1906, 1908; Cole, 1907; Davis, 1903; Haggarty, 1909; Kempf, 1916; Kinaman, 1902; Porter, 1910; Sheperd, 1910, 1911, 1923; Small, 1900, 1901; Witmer, 1910).

In consequence, in discussing imitative learning in animals, one has to

consider a long and venerable history that provides sources of both comfort and confusion: Comfort, in that study of learning by imitation in animals for more than a century suggests the topic of animal imitation is of intrinsic interest; confusion, in that historical diversity in approaches to study of imitative behavior has produced incompatible conceptual frameworks for analysis of imitative phenomena. One man's example of true learning by imitation is another's paradigmatic case of "pseudo-imitation" and each can cite historical precedent for treating phenomena of interest as he does.

Early work on imitation learning is not only of historical interest. The latter half of the 19th century saw the formulation of alternative approaches to the study of imitative phenomena that, even today, shape research in the area. The views of major figures in the behavioral biology and psychology of the last century, provide an important foundation for understanding the origins of much contemporary disagreement and confusion as well as a benchmark from which to measure a century's progress in the study of imitative behavior.

EARLY PERSPECTIVES ON LEARNING BY IMITATION

The major impetus for 19th-century discussion of imitation arose out of disagreement among leading scientific figures of the period concerning the origins of the higher mental faculties of man. Darwin and Wallace, co-formulators of evolutionary theory, differed profoundly over the possibility of employing the principle of evolution, of descent with modification, to understand the development of the human mind. As a contemporary, George Romanes (1884), stated the issue:

... the great school of evolutionists is divided in two sects; according to one the mind of man has been slowly evolved from the lower types of psychical existence, and according to the other the mind of man, not having been thus evolved, stands apart, *sui generis* from all other types of existence. (p. 9)

The dispute was similar to modern debate over whether animals, like men, are capable of conscious thought, "for them to know, or think consciously about the eventual results of what they are doing" (Griffin, 1985, p. 480); the issue today, as in 1884, is the continuity of human and animal mind. In one way, the controversy at the end of the last century was more respectable than its modern counterpart; during the former debate, there was some consensus as to evidence that would decide the issue: indication that animals had humanlike emotions such as shame, remorse, jealousy, and benevolence, that they could use tools or act deceitfully, that they were able to solve complex problems or imitate complex acts.

G. J. Romanes

For both George Romanes, a staunch advocate of the Darwinian view, and for his opponents, demonstrations of imitative learning in animals were seen as providing important evidence of an evolutionary origin of the higher mental faculties of man. The capacity for imitation in animals was viewed as ancestral to the unique human faculty for culture.

Because of the view of phylogeny held by Romanes and many of his contemporaries, failure to find evidence of gradually increasing complexity in imitative behavior as one ascended the great chain of being would have disconfirmed the continuity position. Romanes did not share Darwin's conception of phylogeny as a branching process (Galef, 1986). Rather, Romanes's discussions of evolution have implicit within them the older Spencerian (1855) view (now discredited; Hodos & Campbell, 1969) that it is possible to trace a historically meaningful, linear development of mind across extant species. In consequence, Romanes believed the Darwinian notion of continuity required the presence in living animals of a graded series of primitive precursors of human mental and moral faculties.

Imitation learning was a particularly important test case for Romanes (1884, 1889) because he believed that the imitative faculty reached its highest levels of perfection, not in rational, adult, European man, but in slightly inferior forms: monkeys, children, savages, and idiots (Romanes, 1884, p. 225). Hence, imitation was a faculty one would expect to find, in at least rudimentary form, in species standing yet lower on the psychological scale. Seeking evidences of primitive imitative capacities in animals, Romanes was quick to find them. Romanes's (1884, 1889) classic texts provide many examples.

The first instance of imitation, and the one described by Romanes (1884) at greatest length, is an example of imitation by honeybees of a behavior exhibited by bumblebees.

One morning for the first time, I¹ saw several humble-bees . . . visiting flowers [of the kidney bean], and I saw them in the act of cutting with their mandibles holes through the under side of the calyx, and thus sucking the nectar: all the flowers in the course of the day became perforated, and the humble-bees in their repeated visits of the flowers were thus saved much trouble in suckling. The very next day I found all the hive-bees, without exception, sucking through the holes which had been made by the humble-bees. How did the hive-bees find out that all the flowers were bored, and how did they so suddenly acquire the habit of using the holes? . . . I must think that the hive-bees either saw the humble-bees cutting the holes, and

¹The "I" in this case is actually Charles Darwin. Romanes's 1884 text contains several quotes from an unpublished Darwin manuscript, originally intended as part of *Origin of Species*.

understood what they were doing and immediately profited by their labour; or that they merely imitated the humble-bees after they had cut the holes, and when sucking at them. (p. 220–221)

Romanes then briefly mentions a number of additional cases of imitative learning reported by other correspondents: (1) dogs in the Falkland islands that learned from one another the best way of attacking cattle, (2) chickens learning to respond to “the danger cries and signals employed by other species,” (3) birds imitating the songs of different species, (4) birds of some species that “articulate words” or “songs having a proper musical notation,” (5) dogs foster-reared by cats acquiring feline patterns of behavior such as face-washing, avoidance of water, and stalking mice, (6) juvenile birds taught by their elders to fly, (7) hawks taught by their parents “to more perfectly swoop upon their prey,” and (8) newly hatched chicks learning to drink water by imitating their fellows.

Romanes (1884) justified treating this diverse collection of observations as exemplifying a single underlying process, imitation, by inferring that in each case “there must first be intelligent perception of the desirability of the modification on the part of certain individuals, who modify their actions accordingly” (p. 229).

In Romanes’s view, modification of behavior as the result of interaction with others implied both intelligence and intentionality in the imitator. These inferences of intelligence and intentionality from evidences of imitation were both crucial to Romanes’s main line of argument and a recurring problem in succeeding decades.

If imitation in animals results from psychological processes qualitatively different from those underlying imitation in man (presumed to be intentional and intelligent), then instances of apparent imitative learning in animals are not true precursors of the human faculty for culture; such examples of animal imitation would be, in modern terms, analogues rather than homologues of human imitation. In consequence, Romanes’s use of evidence of imitation in animals to provide a bridge between the minds of animals and the minds of men required interpretation of instances of animal imitation as examples of the exercise of rudimentary versions of humanlike capacities for intelligent, intentional action. J. T. Bonner’s (1980) recent tracing of the evolution of culture has a similar underlying philosophy.

C. L. Morgan

The need to determine whether a given instance of animal imitation depended on faculties of mind similar to those assumed to be employed in imitation learning by humans was recognized early in the history of behavioral biology. C. L. Morgan (1900) proposed that imitation may be of two basic types, either “in-

stinctive,” or “reflective”² and that it is only the latter type, “deliberate and intentional imitation . . . directed to a special end more or less clearly perceived as such” (p. 193), that should properly be considered imitation in the sense the term is used in describing the behavior of humans after infancy.

A chick sounds the danger note; this is the stimulus under which another chick sounds a similar note. . . . Such a procedure may be described as imitative in its effects, but not imitative in its purpose. Only from the observer’s standpoint does such instinctive behaviour differ from other modes of congenital procedure. It may be termed biological but not psychological imitation. And if it be held [as Romanes asserted] that the essence of imitation lies in the purpose so to imitate, we must find some other term under which to describe the facts. This does not seem necessary, however, if we are careful to qualify the term “imitation” by the adjective “instinctive” or “biological”. And the retention of the term [imitation] serves to indicate that this is the stock on which deliberate imitation is eventually grafted (p. 190).

Thus, Morgan departs from Romanes in suggesting that changes in behavior, which to an outside observer appear to be the result of deliberate, conscious imitation, may rest on a different psychological process, instinctive imitation.

In addition to distinguishing instinctive from reflective imitation, Morgan (1900) introduced a further important concept, that of *intelligent imitation*, into discussions of imitative behavior. “Instinctive imitation introduces into the conscious situation certain modes of behavior, and if the development of the situation as a whole is pleasurable, there will be a tendency to its redevelopment under the guidance of intelligence on subsequent occasions” (p. 121).

As William James has proposed in 1892, “every instinctive act, in an animal with memory, must cease to be ‘blind’ after being once repeated” (James, 1961, p. 262). Either instinct or instinctive imitation may introduce behavioral elements into an individual’s repertoire, but its subsequent maintenance, frequency of occurrence, and conditions of expression will reflect nonimitative learning processes, the action of intelligence. The distinction between processes leading to introduction of a pattern of behavior into an individual’s repertoire and those influencing its subsequent expression, first suggested by James and Morgan, is one to which I return later in the present chapter.

E. L. Thorndike

Although both Romanes and Morgan were willing to infer occurrence of learning by imitation from observation of animals of unknown previous history in uncontrolled environments, Edward Thorndike (1911) was far more cautious in accept-

²The same distinction appears in the essays of the Scottish philosopher Thomas Reid (1764), though I do not know whether Morgan was aware of Reid’s analysis of imitation learning.

ing evidence that animals could "from an act witnessed learn to do an act" (p. 79). Thorndike's unwillingness to accept anecdotal evidence of imitation in animals arose from his more general position that "the idea of a response is in and of itself unable to produce that response" (p. 257). If animals could learn to do acts simply by seeing those acts performed, clearly the idea of an act is sufficient impulse for its performance.

Thorndike's attempts to experimentally demonstrate imitation learning in chickens, cats, dogs, and monkeys failed to provide evidence of a capacity for imitation learning. The problem remaining was to explain purported instances of learning by imitation described by his contemporaries. It is in that explanation that Thorndike (1911) provided the conceptual basis for much subsequent experimental investigation of imitative phenomena.

To the question, "Do animals imitate?" science has uniformly answered, "Yes." But so long as the question is left in this general form, no correct answer to it is possible. It will be seen, from the results of numerous experiments soon to be described, that imitation of a certain sort is not possible for animals, and before entering upon that description it will be helpful to differentiate this matter of imitation into several varieties or aspects. The presence of some sorts of imitation does not imply that of other sorts.

There are, to begin with, the well-known phenomena presented by the imitative birds. The power is extended widely, ranging from the parrot who knows a hundred or more articulate sounds to the sparrow whom a patient shoemaker taught to get through a tune. Now, if a bird really gets a sound in his mind from hearing it and sets out forthwith to imitate it, as mocking birds are said at times to do, it is a mystery and deserves closest study. If a bird, out of a lot of random noises that it makes, chooses those for repetition which are like sounds that he has heard, it is again a mystery why, though not as in the previous case a mystery how, he does it. The important fact for our purpose is that, though the imitation of sounds is so habitual, there does not appear to be any marked general imitative tendency in these birds. There is no proof that parrots do muscular acts from having seen other parrots do them. But this should be studied. At any rate, until we know what sort of sounds birds imitate, what circumstances or emotional attitudes these are connected with, how they learn them and, above all, whether there is in birds which repeat sounds any tendency to imitate in other lines, we cannot, it seems to me, connect these phenomena with anything found in the mammals or use them to advantage in a discussion of animal imitation as the forerunner of human. In what follows they will be left out of account, will be regarded as a specialization removed from the general course of mental development, just as the feathers or right aortic arch of birds are particular specializations of no consequence for the physical development of mammals. For us, henceforth, imitation will mean imitation minus the phenomena of imitative birds.

There are also certain pseudo-imitative or semi-imitative phenomena which ought to be considered by themselves. For example, the rapid loss of the fear of railroad trains or telegraph wires among birds, the rapid acquisition of arboreal habits among Australian rodents, the use of proper feeding grounds, etc., may be

held to be due to imitation. The young animal stays with or follows its mother from a specific instinct to keep near that particular object, to wit, its mother. It may thus learn to stay near trains, or scramble up trees, or feed at certain places and on certain plants. Actions due to following pure and simple may thus simulate imitation. Other groups of acts which now seem truly imitative may be indirect fruits of some one instinct. This must be kept in mind when one estimates the supposed imitation of parents by young. Further, it is certain that in the case of the chick, where early animal life has been carefully observed, instinct and individual experience between them rob imitation of practically all its supposed influence. Chicks get along without a mother very well. Yet no mother takes more care of her children than the hen. Care in other cases, then, need not mean instruction through imitation.

These considerations may prevent an unreserved acceptance of the common view that young animals get a great number of their useful habits from imitation, but I do not expect or desire them to lead to its summary rejection. I should not now myself reject it, though I think it quite possible that more investigation and experiment may finally reduce all the phenomena of so-called imitation of parents by young to the level of indirect results of instinctive acts.

Another special department of imitation may be at least vaguely marked off: namely, apparent imitation of certain limited sorts of acts which are somewhat frequent in the animal's life. An example will do better than further definition.

Some sheep were being driven on board ship one at a time. In the course of their progress they had to jump over a hurdle. On this being removed before all had passed it, the next sheep was seen to jump as if to get over a hurdle, and so on for five or six, apparently sure evidence that they imitated the action, each of the one in front. Now, it is again possible that among gregarious animals there may be elaborate connections in the nervous system which allow the sight of certain particular acts in another animal to arouse the innervation leading to those acts, but that these connections are limited. The reactions on this view are specific responses to definite signals, comparable to any other instinctive or associational reaction. The sheep jumps when he sees the other sheep jump, not because of a general ability to do what he sees done, but because he is furnished with the instinct to jump at such a sight, or because his experience of following the flock over boulders and brooks and walls has got him into the habit of jumping at the spot where he sees one ahead of him jump; and so he jumps even though no obstacle be in his way. If due to instinct, the only peculiarity of such a reaction would be that the sense-impression calling forth the act would be the same act as done by another. If due to experience, there would be an exact correspondence to the frequent acts called forth originally by several elements in a sense-impression, one of which is essential, and done afterwards when only the non-essentials are present. These two possibilities have not been sufficiently realized, yet they may contain the truth. On the other hand, these limited acts may be the primitive, sporadic beginnings of the general imitative faculty which we find in man. (p. 76-79)

Explicit in Thorndike's exposition are several ideas: First, acceptance of evidence that social interaction can result in increased similarity in the behavior of interactants; second, the novel view that a wide variety of psychological

processes, not just one or two, can underlie socially induced similarities in behavior. Third, Thorndike is the first to offer a clear alternative to the view that the various types of "semi-imitative phenomena" he described are simpler forms of the "general imitative faculty which we find in man." Thorndike's distinction between pseudo-imitative and imitative behaviors suggests that the processes of social learning seen in man and in animals may be different in kind rather than in degree, that there is no single imitative capacity that appears in various guises in animals possessing nervous systems of varying complexity. Finally, because of the importance of demonstrations of true imitative learning to Thorndike's general theoretical position, the process of imitation was to be used as an explanation of last resort, only after alternative explanations had been excluded.

Summary

By the end of the 19th century the term imitation was being used in three very different senses. Romanes described all instances of socially induced changes in behavior as imitative, assuming that simpler forms were the homologous antecedents of more complex ones. Morgan, although maintaining the use of *imitation* as a generic, wished to distinguish between instinctive and reflective imitation, suggesting that two different psychological processes might underlie superficially similar acquisition process. Thorndike defined imitation in a more restrictive sense than either Morgan or Romanes, as learning to do an act from seeing it performed, and described a number of "pseudo-imitative" processes, qualitatively different from true imitation, that might result in what to the uncritical observer appeared to be true imitation learning, homologous to imitation in man.

TWENTIETH-CENTURY VIEWS ON IMITATION

Unfortunately, the 80 years and more since publication of Thorndike's (1898) monograph have seen no resolution of the conflicting usages of the term imitation already evident at the turn of the century (Morgan, 1900, p. 179). Some continue to use imitation to refer to any instance of social influence on behavior acquisition. Others employ a Morgan-like dichotomy between reflective and instinctive imitation, using the more modern terminology of *imitation* and *social facilitation*. Yet others (including the present author) treat imitation as did Thorndike, as an onerous concept to be employed only when no other explanation of an observed social influence on behavior is possible.

This ambiguity in relationship between labels and phenomena has become increasingly problematic as work on social learning has broadened and scientists with diverse backgrounds attempt to communicate across disciplinary boundaries. Indeed, during the present century, the problem has become more acute in that an elaborate terminology has developed referring to various instances of

imitative learning. We now have available (in addition to imitation, intelligent imitation, reflective imitation, instinctive imitation, and pseudo-imitation), true imitation, allelomimetic behavior, mimesis, proticulture, tradition, contagious behavior, social facilitation, local enhancement, matched dependent behavior, stimulus enhancement, vicarious conditioning, observational conditioning, copying, modeling, social learning, social transmission, and observational learning. To mention but some of the more visible terms.

The superficial impression created by this vocabulary is that the old topic of imitation learning can be divided into distinct subtopics each reflecting different behavioral processes. Unfortunately, this is not the case. There is little agreement as to the proper descriptive to apply to various examples of imitative learning. In consequence, labeling phenomena neither increases understanding nor aids in communication. Although increased understanding can come only from further research, communication may be facilitated by calling attention to current chaos and suggesting ways to circumvent it.

The danger is that discussing terms will encourage reification of what are, generally, vague abstractions reflecting ignorance of the processes underlying social effects on behavior. Thorndike's failure either to provide labels for or attempt precise definitions of the "pseudo-imitative" behaviors he described reflected an appropriate caution in codifying poorly understood phenomena. Even today, the few experiments exploring necessary and sufficient conditions for occurrence of social effects on behavior do not provide an adequate empirical basis for meaningful classification. Yet, we have inherited a rich vocabulary for discussion of imitative phenomena and use of that vocabulary can surely be improved while avoiding both the Scylla of reification and the Charybdis of ambiguity.

In the present section, I discuss terms often found in the literature on imitative phenomena. My goals are (1) to review the vocabulary, (2) to point out contradictions in usage, and (3) in some cases, to make explicit assumptions concealed within the terms themselves that have interfered with analyses of instances of imitative behavior.

Some will surely object to my treatment of one or another of the terms in the lexicon of imitative learning. I can respond only that semantic issues are secondary. Regardless of the labels one attaches to phenomena, the task before us is unchanged, to understand the myriad ways in which social influences on learning and performance contribute to the development and expression of adaptive behavioral repertoires. I hope the following discussion will prove useful in that regard.

Description and Explanation

A recurring problem in discussions and definitions of imitative behaviors has been a failure to differentiate description of observed behaviors from explanation of the processes responsible for the occurrence of the behaviors observed. Too

often the observation that social interaction is important in the acquisition of a behavior has been used to infer that a particular learning process (imitation, social facilitation, local enhancement, etc.) is responsible, without the necessary analytic investigations being carried out. Thus it seems to me that a necessary first step in discussion of the vocabulary of imitation is to clearly distinguish descriptive from explanatory terminology. In the present section, I first introduce and discuss three descriptive terms (*social learning*, *social enhancement*, and *social transmission*) and then proceed to consider terms referring to processes that might produce any given instance of social learning, social enhancement, or social transmission.

Descriptive Terms

Social Learning: Imitation, Observational Learning. Morgan (1900) proposed *imitation* as a generic to refer to all cases in which social interaction functioned to modify the probability of a naive individual's exhibiting or acquiring some pattern of behavior exhibited by others. Although he was surely correct in suggesting that a generic would be useful, the term *imitation* has acquired too many meanings in intervening years to be unambiguous when used in that way. Hall (1963) suggested *observational learning* "to avoid the conundra associated with [use of] imitation" (p. 206) though, over the years, *observational learning* also has become subject to diverse usages.

H. O. Box (1984, p. 213) introduced *social learning* as a generic. It is theoretically neutral and suggests a dichotomy between learning that is influenced socially and instances of individual learning in which behavior acquisition is not influenced by interaction with others.

It should be kept in mind, however, that even the distinction between individual and social learning is not so clear as one might hope. It is obvious that in the final analysis it is always individuals that learn. As Morgan indicated, social interaction may facilitate introduction of a pattern of behavior into an individual's repertoire. However, if that pattern of behavior is maintained, such maintenance is the result of favorable consequences resulting from performance of the behavior. Thus, although social learning may play a role in facilitating acquisition of behavior, it may be misleading to refer to a behavior exhibited by an animal as socially learned.

Social Enhancement: Coaction, Social Facilitation. Clayton (1978) has defined *social facilitation* as "an increase in the frequency or intensity of responses or the initiation of particular responses already in an animal's repertoire, when shown in the presence of others engaged in the same behavior at the same time" (p. 374). Zajonc (1964) used *coaction* to refer to the same effects. In defining social facilitation, Clayton emphasized a distinction between social effects on the performance of behaviors already in an animal's repertoire and social effects on acquisition processes. At a descriptive level, this distinction seems valuable.

Clayton specifically excluded from consideration as socially facilitated, in-

stances of behavior in which simple presence of others increased performance of behaviors already in a subject's repertoire. Thus, in Clayton's usage, social facilitation has both descriptive and explanatory connotations. (Use of social facilitation as an explanatory term is discussed later.) Clearly, it is an empirical question whether socially induced enhanced performance is the result of the behavior of others or of their simple presence.

It would be useful to have available a generic to refer to all social influences on performance of established responses, independent of underlying mechanism, to provide a framework within which analytic investigations could be conducted. There is, so far as I know, no such term in the literature and I propose *social enhancement* for that purpose. The problem with *social facilitation* is that it, like *imitation*, has been defined in so many ways by so many authors that it no longer has any clear referent. (Compare, for example, Crawford, 1939; Clayton, 1978; Thorpe, 1963; Wechkin, 1970; and Zajonc, 1965.)

I would also include as instances of social enhancement, effects on performance resulting from the presence of residual traces others leave in a shared environment. It is, again, an empirical question whether, in any particular case, the presence or activity of others is necessary to produce social enhancement of performance. Even during periods of coaction, coactors may, for example, release chemicals that are responsible for any observed social enhancement of behavior.

Simple presence of others, presence of behaving others, or presence of residual cues emitted by others could each, at least in principle, enhance performance of responses already in an individual's repertoire. A generic such as *social enhancement* would be useful to refer to such effects as distinct from *social learning*, i.e., cases of social effects on acquisition and extinction processes.

Social Transmission: Protoculture, Subculture, Preculture, Tradition. For historical as well as theoretical reasons, cases of social learning that result in increased homogeneity of behavior of interactants that extends beyond the period of their interaction are an important subset of socially learned or socially enhanced behaviors. I have proposed (Galef, 1976) calling such behaviors *socially transmitted*, in that social interaction increases the probability that one individual will come to independently exhibit a behavior initially in the repertoire of another.

I have suggested limiting use of the term *socially transmitted* to those instances of social learning or social enhancement in which (1) social interaction is not a necessary condition for the ontogeny of a pattern of behavior; (2) the change in behavior resulting from social interaction is increased homogeneity of the behavior of interactants; and (3) this increased homogeneity of behavior extends in time beyond the period of interaction between transmitter and recipient. These three criteria distinguish forms of social learning that might act to disseminate patterns of behavior through a population from those incapable of doing so.

There are many interesting social learning phenomena that are not in-

stances of social transmission. For example, West, King, and Harrocks (1983) have shown that the song of male cowbirds is modified by interactions with conspecific males and females. Although social learning results from these interactions, they often do not produce increased homogeneity in the behavior of interactants. Harlow and Harlow's (1965) demonstrations of the necessary role of social interaction in the development of normal patterns of sexual and maternal behavior in rhesus monkeys would be an instance of social learning, but not social transmission. In this case, social interaction is obligate and not facultative for development of behavior. (See Galef, 1976, for further discussion.)

The purpose of distinguishing social transmission from social learning is to differentiate social interactions that facilitate the spread of idiosyncratic behaviors through a population, that can produce protoculture (Count, 1973), preculture (Kawai, 1965), subculture (Kawamura, 1959) or tradition (Kummer, 1971), from those that can not.

Explanatory Terms

Selection of descriptive terms is not particularly contentious. Greater problems arise in choosing terms to refer to behavioral processes that support social enhancement, social learning, and social transmission. Existing explanatory terminology is extensive, contradictory, and vague, and, in my view, of little use in analysis of the behavioral phenomena to which it refers. Attaching explanatory labels to phenomena has frequently both served to hide ignorance of underlying process and interfered with further investigation, rather than clarified issues.

Careful experiment can determine whether social interaction plays a role in development of a behavior, can define necessary and sufficient conditions for social influence, can identify social stimuli that modify behavior, and so forth. However, in the absence of clearly defined, mutually exclusive categories, each reflecting a unique process underlying social learning or social enhancement, there is little to be gained by explaining instances of social learning as produced by one type of social learning rather than another.

During the period when general process theories of individual learning dominated experimental animal psychology, advance in study of social learning seemed to require identification of social learning analogues of such individual learning processes as operant and classical conditioning. If one could elucidate critical features of paradigmatic cases of social learning, then social learning could be studied at the same level of abstraction as individual learning (Jenkins, 1984).

However, study of social learning was, from its inception, more profoundly influenced by field observation than was study of individual learning. The need to discuss cases of "imitation" reported in the field literature required attention to a broad range of phenomena, the complexity of which defied simple categorical schemes. Perhaps in consequence, assimilation of the study of social learning into the methodological framework that dominated study of individual learning in the psychological laboratory did not occur.

Attempts at classification of instances of social learning according to underlying behavioral mechanisms, though failing to reach their primary goal, did prove useful. Such attempts were heuristic in suggesting experimental approaches to analysis of social learning phenomena. This heuristic value becomes evident if one treats attempts at classification as extensions of Thorndike's (1898) list of vaguely defined "pseudo-imitative" processes that can produce social learning, rather than as formal classificatory schemes.

Local Enhancement and Stimulus Enhancement. Probably the most frequently used term in analyses of social learning is *local enhancement*, introduced by Thorpe (1956) in his discussion of evidences of ideation in animals. Thorpe (1963) defined local enhancement as "apparent imitation resulting from directing the animal's attention to a particular object or to a particular part of the environment" (p. 134). The term has usually been used to refer to instances in which animals directly interact, though this restriction seems to me unnecessary. If, for example, rats mark foods they have eaten, thereby increasing the probability that conspecifics will eat the same foods (Galef & Beck, 1985), or leave scent trails as they move about the environment, inducing others to follow the same path (Telle, 1966), the absence of the initiator of the pattern of feeding or movement at the time of acquisition by a second individual does not seem to me to change the nature of the basic process.

Thorpe's hypothesis that local enhancement is the result of increased attention to certain objects or places is also unnecessarily restrictive. Consider Thorndike's (1911) example of the rapid loss of fear of railroad trains among birds, quoted above and interpreted by Thorndike as due to an inherent tendency to follow or affiliate. It seems unlikely that birds lose their fear of trains as a result of socially induced enhanced attention to them. Socially induced increased exposure to trains and consequent habituation to the threatening stimuli that trains emit seem a likely explanation of the observed social transmission of behavior.

A tendency on the part of naive individuals to approach conspecifics, alterations conspecifics have made in the environment, or objects they have contacted, can increase a naive individual's probability of exposure to one set of stimuli rather than others. Enhanced exposure can lead to habituation, familiarity, perceptual learning, latent learning, increased probability of manipulation of one portion of the environment, and so forth. All such socially initiated alterations in behavior seem to me to be instances of local enhancement and, in consequence, Thorpe's 1963 definition appears too narrow.

Use of the term local enhancement to describe an instance of social learning should not be allowed to conceal the fact that we remain ignorant of many important features of social interactions labeled in this way: the necessary and sufficient conditions for one organism directing the behavior of another to some portion of the environment, whether, in fact, changes in focus of "attention" actually have anything to do with such phenomena (Davis, 1973).

Spence (1937) used the term *stimulus enhancement* to refer to "a change in stimulus conditions, the enhancement of the particular limited aspect of the total stimulus situation to which the response is to be made" (p. 821). Although Spence's term never achieved the frequency of usage of Thorpe's local enhancement, it is in my view preferable, both avoiding reference to unobservable attentional processes and broader in scope than is Thorpe's use of local enhancement. The notion of stimulus enhancement, as defined by Spence, extends the concept of local enhancement to include the entire class of objects sharing stimulus characteristics with an object a demonstrator manipulates, contacts, or marks.

Investigators employing the duplicate-cage method (Warden & Jackson, 1935), in which a demonstrator and observer are kept in separate enclosures and contact separate, identical manipulanda to receive reinforcement, have frequently not considered local enhancement as an explanation of observed social effects on learning (Suboski & Bartashunas, 1984; Warden & Jackson, 1935; Zentall & Levine, 1972). Given Thorpe's narrow definition of local enhancement they should not have. However, stimulus enhancement could play a role in facilitating learning in many situations in which local enhancement could not occur. Thus, use of Thorpe's narrow definition of the phenomenon of local enhancement can obscure possible explanations of social learning phenomena.

Social Facilitation. Zajonc (1965, 1969) has suggested that the simple presence of others "energizes all responses made salient by the stimulus situation confronting the individual at the moment. Among those, the dominant responses (i.e., those most likely to be emitted) are assumed to derive the greatest benefit from the presence of others" (1969, p. 10). Experimental evidence of such "social facilitation" is surprisingly scant. In most cases described in the literature, the others present are engaged in the same behavior as the subject and there is no opportunity to observe the effects of pure social facilitation in Zajonc's sense. Some studies designed to separate the effects of the simple presence of others from the effects of others engaging in the target behavior (e.g., Galef, 1971; Strobel, 1972; Tolman & Wilson, 1965) have failed to find evidence of such social facilitation; other studies have found such effects, though they are generally not large (Levine & Zentall, 1974; Zentall & Hogan, 1976).

Clayton (1978) has proposed that in some studies in which behavior was alleged to increase in frequency in socially stimulated, as compared with isolate animals (e.g., Pishkin & Shurley, 1966; Tolman, 1967), social facilitation resulted from disinhibition of behavior by reduction of isolation-induced fear. Fear reduction or reduction in arousal resulting from the presence of conspecifics is known to have profound effects on behavior (e.g., Campbell & Raskin, 1978; Kaufman & Hinde, 1961; Randall & Campbell, 1976; Stamm, 1961) and, in consequence, it is difficult to determine whether, as Zajonc proposed, the simple presence of others also has energizing effects on behavior. Whether fear reduction

or social facilitation is involved, it seems reasonable to suppose that members of some species are, for example, more likely to exhibit feeding behavior in an area that contains other individuals than in one that does not.

Although social facilitation in Zajonc's sense of the term is a form of social enhancement, it could play a role in social learning or social transmission via processes analogous to Morgan's intelligent imitation. For example, Sullivan (1984a) found that downy woodpeckers, when feeding in a mixed species flock, reduced the time they spent "looking-out" and increased the time they spent feeding. Contact calls of chickadees played through a loudspeaker also increased the time spent feeding by the downy woodpeckers (Sullivan, 1984b). Stimuli indicating the simple presence of chickadees rather than chickadee feeding behavior facilitated woodpecker feeding.

If woodpeckers are sensitive to the different foraging rates they exhibit when alone and when in mixed species flocks, flock-induced augmentation of feeding rate could be the proximate cause of flock joining. The tendency to join flocks of chickadees could modify choice of feeding patches by woodpeckers. Changes in patch selection could influence prey selection. Thus, although social facilitation cannot itself produce social transmission, in concert with individual learning, it too might play a role in social transmission processes.

Contagious Behavior: Mimesis, Allelomimetic Behavior, Instinctive Imitation, Social Facilitation. Yet another long-recognized process that may result in social enhancement of behavior is that which Morgan (1900) and Washburn (1908) called instinctive imitation, Thorpe (1963) called both social facilitation and contagious behavior, Armstrong (1951) and Verplanck (1957) labeled mimesis, Scott (1958) allelomimesis, and both Mowrer (1960) and Humphrey (1921) called imitation. Because social facilitation and imitation have been widely used in other contexts, I prefer *contagious behavior* to refer to situations in which "the performance of a more or less instinctive pattern of behavior by one will tend to act as a releaser for the same behavior in others and so initiate the same line of action in the whole group" (Thorpe, 1963, p. 133). Yawning in humans (Thorpe, 1963), chorusing in roosters or dogs (Humphrey, 1921), maneuvering in flocks of birds or schools of fish, the "flying up" of partridge or quail (Armstrong, 1951; Scott, 1958) have all been discussed as exemplifying contagious behavior.

Processes other than instinctive response to releasing stimuli have been proposed to account for such contagious behaviors. Humphrey (1921), suggested the following hypothetical example:

Suppose that a herd of cattle is feeding together and something occurs to startle them . . . all manifest signs of fear and run . . . Any individual, A, will as he runs, see his fellows running, and this will have always occurred whatever the stimulus. Hence the sight of a running fellow will act as a conditioned stimulus for the activity of running. (p. 4)

In this case, contagious behavior is seen as resulting from response to classically conditioned stimuli rather than unconditional releasers. (See also Church, 1959.)

Obviously, contagious behavior, though sufficient to produce social enhancement, is itself inadequate to produce social learning or social transmission. However, as Morgan indicated in his discussion of intelligent imitation, in combination with individual learning, contagious behavior may play an important role in both. (See, for example, Suboski & Bartashunas, 1984.)

Observational Conditioning: Vicarious Instigation, Pseudovicarious Instigation. Berger (1962, p. 450) introduced the term *vicarious instigation* to be employed "If an observer responds emotionally to a performer's unconditioned emotional response . . ." and distinguished true vicarious instigation from various forms of *pseudovicarious instigation*. Among the latter, Berger (1962) suggested that "a performer's unconditioned response [to a stimulus] may be an unconditioned stimulus which elicits an observer's emotional response; in this case the observer responds to the performer's unconditioned response [not to the performer's emotional response] so that the performer's unconditioned stimulus and unconditioned emotional response are superfluous" (p. 451). Thus, in Berger's view, vicarious instigation is not a form of emotional contagious behavior; vicarious instigation is dependent upon an observer's inference or perception of the emotional state of a performer. In vicarious instigation, a scream does not elicit fear in an observer; this would be a form of pseudovicarious instigation. In vicarious instigation perception of the fear of the screamer elicits fear in an observer.

Whether animal observers respond emotionally to the stimuli emitted by an emotionally aroused performer or respond emotionally to inferences as to the emotional state of performers arrived at by integrating contextual information with information in the display of the performer, the result would be similar. A response to an emotion-eliciting stimulus by one animal could elicit an emotional response in an observer. Stimuli experienced by the observer in temporal contiguity with its socially elicited emotional response might, in turn, acquire classically conditioned emotion-evoking capacity.

A number of interesting instances of social transmission of behavior discovered in recent years appear to be the result of processes of this type, labeled *observational conditioning* by Cook, Mineka, Wolkenstein, and Laitsch (1985). In discussion of learning in animals, I prefer *observational conditioning* to *vicarious instigation* unless and until there is reason to believe that animals make the complex inferences the latter term requires.

Curio, Enst, and Vieth (1978) have found that jackdaws exposed to an arbitrary stimulus while listening to mobbing calls of conspecifics subsequently give a mobbing call in response to presentation of the arbitrary stimulus. Mineka and coworkers' (1984, 1985) studies of the development of snake avoidance in rhesus monkeys have shown that observation of an adult exhibiting fear of a snake leads to avoidance of snakes in naive juveniles (Cook et al., 1985; Mineka, Davidson, Cook, & Keir, 1984).

The rapidity with which these conditioned responses are established suggests that, if they do depend on classical conditioning for their development, they may be instances of adaptively specialized learning processes analogous to that hypothesized to underlie taste-aversion learning in rats (Rozin & Kalat, 1971). Further, in natural circumstances, a naive conspecific observer of a fearful rhesus or mobbing jackdaw is likely to perceive the upset conspecific prior to detecting the stimulus to which it is reacting. Thus, if observational conditioning occurs in nature, experience of the US prior to the CS (e.g., backward conditioning) should not disrupt observational conditioning as it does other forms of Pavlovian learning.

Matched Dependent Behavior. The process of operant conditioning, like that of classical conditioning, has been suggested as a mechanism for both social learning and social transmission of behavior. Miller and Dollard (1941) in their classic text *Social Learning and Imitation* introduced the term *matched dependent behavior* to refer to situations in which the application of external reinforcement leads organisms to match their own behavior to that of conspecifics. In matched dependent behavior, the behavior of one animal (the leader) serves as a discriminative stimulus for a second animal (the imitator), indicating those occasions on which the imitator will be reinforced for performing some behavior. For example, Miller and Dollard (1941) trained rats either to make the same choice as their leader at the junction of a T-maze or to make the opposite choice from the leader to receive food reinforcement. The choice by a leader of, for example, the left arm of the maze served in both cases as a discriminative stimulus, eliciting left or right turning in the follower depending on the reinforcement contingencies to which the follower had been exposed. Skinner (1953) has argued that appropriate contingencies for the development of matched dependent behavior often occur in nature. "Thus, if a pigeon is scratching in a leaf-strewn field, this is an occasion upon which another pigeon is likely to be reinforced for similar behavior" (p. 120).

Although the matched dependent process is sufficient to produce a degree of uniformity in the behavior of pairs of animals, once the leader (the discriminative stimulus) departs, those aspects of a follower's behavior dependent on the presence of the leader are lost. For the pattern of behavior initiated by the leader to become part of the behavioral repertoire of the follower, independent of the leader, the pattern of behavior must come under the control of stimuli not dependent on the presence of the leader.

Church (1957, 1968) has provided evidence that incidental learning can result in the transfer of stimulus control of behavior from a leader organism to other stimuli in the environment. Rats first trained to follow a leader into the left and right arms of a T-maze, then exposed to a number of trials in which they always followed the leader into the arm of the T-maze marked by a light, when subsequently tested without the leader, entered the lighted arm of the maze. Thus, matched dependent behavior, acting in concert with incidental learning,

provides a mechanism for social transmission of behavior among conspecifics (Bayroff & Lard, 1944; Solomon & Coles, 1954; Stimbert, 1970).

Copying: "vocal imitation". Miller and Dollard (1941) distinguished *copying* from the *matched dependent behavior* described above in terms of whether an observer simply used its model's behavior as a discriminative stimulus for the occasion to exhibit the reinforced behavior or was sensitive to the relationship (same or different) between its own behavior and that of its model. In either case, one would observe the development of similar behavior in model and subject as the result of differential extrinsic reinforcement. However, the underlying process of behavior acquisition by the social learner would differ in the two cases.

According to Miller and Dollard (1941), in the initial stages of copying, an external agent both punishes responses of the subject that are different from those of its model and reinforces responses similar to those of its model. In time, Miller and Dollard propose, the copier comes to experience anxiety when producing responses differing from those of models and relief from anxiety when producing responses similar to those of models.

Early stages of the development of copying in Miller and Dollard's exposition seem to require action by an external agent consciously differentially reinforcing same and different responses. Such deliberate tuition has not been demonstrated in any species other than our own (Ewer, 1969). In consequence, copying, in Miller and Dollard's sense, seems unlikely to occur in animals and Miller and Dollard (1941) provide no examples of copying in nonhuman species.

Thorndike's (1911, p. 76-77) discussion of vocal imitation in birds, quoted in the first section of the present chapter, assumes a process similar to Dollard and Miller's copying, i.e. a sensitivity of the imitator to the degree of similarity of its vocal output to the auditory input it is imitating. Thorndike's model, however, rests on an assumed intrinsic motivation in some species of bird to experience as rewarding production of vocalizations similar to previously experienced auditory stimuli.

Thorndike (1911) saw such vocal imitation in birds as dependent on a specialized process not seen either in other species or in other instances of social learning by birds. In one sense, any vocal copying is unique in that the feedback from the copier's output is perceived via the same sensory modality that the signal to be copied was originally perceived (McDougall, 1924, p. 174). A talking or singing bird receives auditory feedback from its vocal output that can be matched with a stored representation of an auditory signal, the human speech or bird song the copier originally heard. Copying of motor outputs other than vocalizations requires the copier to make cross-modality comparisons between a models' behavior and its own and, therefore, seems intuitively less likely.

As Thorndike proposed, the ability of parrots and some other birds to reproduce human vocalizations and of some songbirds to learn dialects suggests an intrinsic motivation to respond differently to their own production of familiar

and novel sounds, but other explanations are possible. Mowrer (1960) described a process, sufficient to produce copying of human vocalizations by birds, though insufficient to account for some results of studies of acquisition of dialect by birds (for example, those in which adult song is played to juveniles through loud-speakers; Marler & Tamura, 1964). On Mowrer's (1960) model, the necessary condition for vocal imitation of humans by birds is the formation of an emotional attachment to a human caretaker (see also Lashley, 1913; Pepperberg, 1985; West, Stroud, & King, 1983). According to Mowrer (1960), if the caretaker, a source of reinforcement, produces auditory signals in the presence of the subject, these sounds

become positively conditioned, i.e. they become *good sounds*; and in the course of its own, at first largely random vocalizations, the bird will eventually make somewhat similar sounds. By the principle of generalization, some of the derived satisfaction or pleasure which has become attached to the trainer's sounds will now be experienced when the bird itself makes and hears like sounds; and when this begins to happen the stage is set for the bird's learning to "talk." (p. 79)

Recent studies (Baptista & Petrinovich, 1984; Petrinovich, 1985) indicating that important aspects of song acquisition differ between those white-crowned sparrows exposed to recorded song and those exposed to a live, interacting tutor suggest that social learning of the type Mowrer proposed may be important in some aspects of vocal learning by birds. (See Pepperberg, 1985, for discussion.)

Whether copying of the type to be seen in talking or singing birds should be considered true learning by imitation is, like any semantic issue, open to debate. Such copying lacks the goal directedness that is a central feature of many definitions of imitation and, at least in the models proposed by Dollard and Miller, Thorndike, and Mowrer, can be seen as an extension of operant or classical conditioning rather than as reflecting a capacity for imitative learning.

Imitation or Observational Learning

As mentioned in discussion of 19th-century work on imitation, early study of social learning in animals was largely motivated by the question of whether observed coincidence in the behavior of interacting organisms provided evidence of *reflective imitation* (Morgan, 1900) or *true imitation* (Thorpe, 1963) in Thorndike's (1898) sense of "learning to do an act from seeing it done." True reflective imitation requires that the sight of an act be sufficient instigation to the act. It suggests purposeful, goal-directed copying of the behavior of one animal by another. Demonstration of true imitation would require a far more cognitive approach to the study of animal behavior than has generally been pursued by laboratory investigators. Hence, convincing demonstrations of observational learning or imitation (which I treat as synonymous) would, as Thorndike implied, have profound consequences for our understanding of animal behavior.

