calizations, which by definition produce no sound? Are the relevant stimuli akin to auditory hallucinations (Jaynes, 1977)? Are they like the abbreviated articulatory muscle movements of the motor theory of consciousness (Max, 1934)? In either case, what might the phylogenic origins of such discriminations of the covert be?

Perhaps it does not matter whether we can identify receptors (although Skinner, 1988, p. 194, argued that we cannot introspect cognitive processes "because we do not have nerves going to the right places"). It would be gratuitous, however, to assume that one cannot help knowing that one is talking to oneself. After all, individuals sometimes talk to themselves overtly without knowing it, and the covert should be less discriminable by virtue of its lesser magnitude. Horne and Lowe allude to the implications their account has for the concept of verbal consciousness, but the problem of covert verbal behavior implies that the resolution lies with applying the analysis of the language of private events (as in Skinner, 1957, pp. 130–146) to the synthesis of naming.

THE EVIDENCE FOR NAMING AS A CAUSE OR FACILITATOR OF EQUIVALENCE CLASS FORMATION

LANNY FIELDS

THE COLLEGE OF STATEN ISLAND AND
THE GRADUATE SCHOOL AND UNIVERSITY CENTER OF
THE CITY UNIVERSITY OF NEW YORK

Naming is a term that has eluded a clear definition by scholars in a variety of disciplines. Drawing from a broad range of literature, Horne and Lowe offer a behavioral definition of naming, account for the emergence of naming, and then use naming as an alternative account of the emergence of equivalence classes. Their arguments, however, have a number of interpretative and logical difficulties, each of which will be discussed below.

Horne and Lowe use two data sets to support the hypothesis that naming accounts for the emergence of equivalence classes: (a) Equivalence classes are not formed by nonhumans or by children who do not have naming repertoires, and (b) when human subjects fail to form equivalence classes, the classes then emerge after the subjects are taught or required to name the stimuli in the potential classes. Their interpretations of both data sets to support the naming hypothesis are problematic.

Citing a number of studies with nonhuman subjects who did not form equivalence classes, Horne and Lowe conclude that naming is critical for the development of equivalence classes. An argument based on negative findings, however, can be refuted by only one positive finding. Research with pigeons (Urcuioli, Zentall, Jackson-Smith, & Steirn, 1989; Vaughan, 1988; Wasserman, DeVolder, & Coppage, 1992; Zentall & Urcuioli, 1993), with rats (Dube, McIlvane, Callahan, & Stoddard, 1993; Hall, Ray, & Bonardi, 1993), and with a sea lion (Schusterman & Kastak, 1993) provide data indicative of the emergence of equivalence classes by nonhuman organisms, who apparently do not use naming. These data, then, do not support an assertion that naming is necessary for equivalence class formation.

Schusterman and Kastak (1993), in the

Address correspondence to the author at The College of Staten Island/CUNY, 2800 Victory Boulevard, Staten Island, New York 10314.

only animal study that is considered at length by Horne and Lowe, showed the immediate emergence of 18 new equivalence classes. The presumed methodological shortcomings of that experiment identified by Horne and Lowe, and the alternative interpretation of their results, which was based on compound stimuli, are neither compelling nor persuasive. Indeed, if the stimulus compounding explanation were accepted, it would provide a more parsimonious account of the emergence of equivalence than does the naming hypothesis.

Horne and Lowe also consider accepting the Schusterman and Kastak (1993) data as being a demonstration of equivalence class formation. That position, however, is presented with a caveat; if an animal were to pass tests for equivalence, "what would it tell us about . . . the performance of humans who pass equivalence tests . . . what, if anything, [does this have] . . . to do with language and naming" (p. 233)? This implies that nonhumans may form equivalence classes by processes other than those used by humans. Such a human-nonhuman discontinuity assumption provides an "escape hatch" that discounts findings of equivalence class formation by nonhumans. It appears, then, that the naming account could not be disconfirmed by any empirical demonstration of equivalence class formation by nonhuman subjects.

Horne and Lowe support the naming hypothesis by citing work in which failures to form equivalence classes by humans were rectified by subsequently training subjects to name the stimuli in the sets. Because the use of naming was correlated with the emergence of the classes, naming was taken as a cause of class formation. In all of these studies, however, the responses occasioned by the stimuli need not be names; they could be simple discriminated operants. Because that distinction was not made in any of the experiments, the results of the experiments do not provide persuasive support for the naming hypothesis.

Above, I raised questions about empirical support for the naming account of equivalence class formation. Those comments, however, do not imply that differential responding or naming, however defined, will not influence equivalence class formation (Bentall, Dickins, & Fox, 1993; Dickins, Bentall, & Smith, 1993). Indeed, it is quite conceivable that equivalence class formation would be facilitated more by training a subject to emit names instead of responses that were simple discriminated operants. The discriminated operant-naming distinction, however, would have to be more substantive than the pronounceability distinctions noted by Mandell and Sheen (1994).

Horne and Lowe do not consider cases in which individuals with presumably well-developed naming repertoires fail to form equivalence classes or show the expansion of class size (Adams, Fields, & Verhave, 1993; Fields, Adams, Newman, & Verhave, 1992). In these studies, different training and testing protocols were used to establish equivalence classes, and different percentages of subjects showed the emergence of equivalence classes. Naming was not tracked within trials. If it is assumed that naming determines performances indicative of equivalence class formation, and that naming is used in equal degree by all subjects, the same percentage of subjects should have formed classes regardless of protocol. Alternatively, it could be argued that the protocols influenced the naming repertoires, which in turn influenced likelihood of class formation. Regardless of interpretation, the data do not appear to support the naming hypothesis.

Although Horne and Lowe argue that naming facilitates the formation of equivalence classes (e.g., Dugdale & Lowe, 1990), such an effect may occur for reasons unrelated to naming. Consider the following example: An attempt is made to establish a two-node four-member equivalence class consisting of visual stimuli by training the stimulus-stimulus relations AB, BC, and CD. After failing the emergent relations tests, the subject is trained to emit some operant (saying "x"), which produces the auditory stimulus "eks" in the presence of the A, B, C, and D stimuli in a set. Because the response has an auditory product, the order of events that precede the reinforcer is A–Rx–"eks" → Sr. The reinforcer establishes the stimulus-response relation (A-Rx) and the visual-auditory stimulus-stimulus relation (A-"eks") (Colwill & Rescorla, 1988; Schoenfeld & Cumming, 1963). Similar contingencies establish the relations B-"eks," C-"eks," and D-"eks." These contingencies

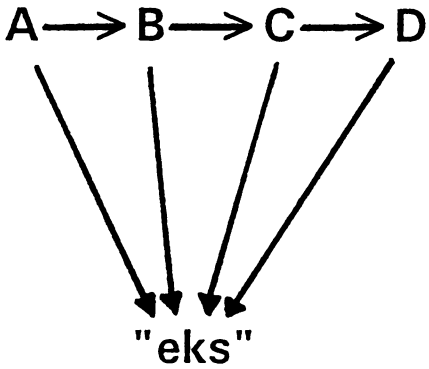

Figure 1.

produce many other changes in the potential classes: (a) A potential four-member class (A, B, C, D) is converted to a potential five-member class (A, B, C, D, and "eks"). (b) While attempting to establish the four-member class, three conditional relations are trained: This is the maximum number that can be directly trained to obtain an equivalence class (Fields & Verhave, 1987). When the naming contingency was used, the potential class size increased to five members. Although a maximum of four conditional relations can be trained to form a five-member equivalence class, in actuality, seven stimulus-stimulus relations were trained (AB, BC, CD, A-"eks," B-"eks," C-"eks," and D-"eks"). The resultant class would be represented by the diagram in Figure 1. The trained relations, indicated by each arrow, exceed the maximum needed to form an equivalence class. Therefore, the class that can emerge would be an arbitrary stimulus class but not an equivalence class (Stromer, McIlvane, & Serna, 1993). (c) The naming requirement converted a potential two-node class, in which B and C were nodes, to a potential class in which all five stimuli (A, B, C, D) function as nodes. This occurs because each stimulus is linked by training to at least two other stimuli, as indicated in Figure 1. (d) Whereas the four-member class has a linear nodal structure, the potential five-member stimulus class has a many-to-one or comparison-as-node-like structure when one considers the nodal function of the "eks" stimulus. (e) A potential class of visual stimuli only was converted to a class containing visual and auditory stimuli.

Each of the conversions listed above can be implemented experimentally without recourse to the contingency used to establish the naming repertoires. With the exception of (a), each of these changes would predict facilitation of class formation without consideration of naming. Because this account bases predictions on measurable events and fewer assumptions than the naming account, it provides a more parsimonious explanation of the data than does the naming account.

The article considers equivalence classes with only one nodal stimulus. Many classes, however, contain more than one nodal stimulus (Fields & Verhave, 1987). Many test performances are an inverse function of nodal distance (Bentall et al., 1993; Dickins et al., 1993; Fields, Adams, & Verhave, 1993; Fields, Adams, Verhave, & Newman, 1990, 1993; Fields, Landon-Jimenez, Adams, & Buffington, 1995; Kennedy, 1991; Kennedy, Itkonen, & Lindquist, 1994; Sidman, Kirk, & Willson-Morris, 1985). How would the naming account deal with the effects of nodal distance? Such a consideration would clarify the robustness and explanatory power of the naming hypothesis.

Horne and Lowe propose that class-consistent performances on symmetry, transitivity, and equivalence tests are actually not novel performances. Rather, they are responses controlled by intraverbals and the stimuli in a test trial. Although the terms are different, the explanatory mode of the naming account is very similar to the explanation of emergent performances presented long ago by Cofer and Foley (1942), Jenkins (1963, 1965), and Osgood (1953) in their discussions of mediated generalization. In balance, the essential differences claimed by Horne and Lowe are not as compelling as the functional similarities.

Horne and Lowe propose a mechanism (naming) to account for the emergence of the performances indicative of equivalence classes. Perhaps they do not go far enough. A more radical and potentially more parsimonious account is postulated by Donahoe and Palmer (1994). Neuronal networks are established by conditional discrimination training. The interactions of neural activity in the network occasioned by the stimuli presented on emergent relations test trials lead to responses that are indicative of equivalence classes. This model accounts for emergent

performances without recourse to naming and subsumes the animal as well as the human data. It is also grounded in current neuroscience. The functions of such networks have been modeled by Barnes and Hampson (1993). A connectionist network that contained one hidden layer produced the emergent performances that were analogous to those obtained by Wulfert and Hayes (1988). These data then support a neurologically based interpretation of equivalence class formation.

Thus, the proposal that naming accounts for equivalence class formation is based on the assessment of correlated occurrences of naming performances and performances indicative of equivalence class formation. There are four possible combinations of these performances. A particular set of outcomes is needed to support the view that naming produces equivalence. Given the correlational nature of the data, however, a causal relation could not be proven. Support requires unequivocal demonstrations that (a) classes emerge when naming is present, and (b) classes do not emerge when naming is absent. Evidence that would not support the naming hypothesis include (c) failures of class formation when naming is present, and (d) the emergence of classes in the absence of naming. When viewed within these decision-making constraints, the data cited by Horne and Lowe do not provide unequivocal demonstrations of (a) and (b). Indeed, data cited by them and other evidence are characterized by the correlations mentioned in (c) and (d). Thus, it does not appear that a compelling case cannot be made to account for the emergence of equivalence classes by naming. A further clarification of the issue will depend on the gathering of additional experimental data, addressing issues mentioned above, and further clarifications in the interpretation of existing data.

LISTENING WITH UNDERSTANDING AND SPEAKING WITH MEANING

LINDA J. HAYES

UNIVERSITY OF NEVADA

Parrott (1984) has argued that Skinner's (1957) analysis of verbal behavior as nonverbal acts of reinforcement mediation for a speaker's behavior is imprecise, in that cases in which reinforcement mediation does not occur cannot be differentiated as to their sources. For instance, reinforcement mediation for a speaker's mand may not occur because the listener did not hear the request due to ambient noise, or it may not occur because the listener does not understand the request (e.g., when it is made in an unfamiliar language), or it may not occur because the mand does not establish circumstances that result in the speaker's compliance as a reinforcer for the listener. That is to say, in this last case, reinforcement mediation may not occur because the listener is not motivated to comply with the speaker's mand. To rectify this situation, Parrott (1984) provided an account of listening and understanding per se in which listening was taken to be differentiated and evolving activity with respect to auditory stimulation; understanding was taken to be implicit responding with respect to things and events historically associated with aural interactions, occurring by way of acquired or substitutional functions of auditory stimuli.

Address correspondence to the author at the Psychology Department, University of Nevada, Reno, Nevada 89557.