ment. The fact that words can evoke sensory images of objects or events, due to a process of Pavlovian conditioning, was acknowledged by Skinner. But, as Skinner adds, this leaves out a large number of words. Moreover, he points out that sentences do not just refer to objects, they say something about them.

It is hard to see how Horne and Lowe's notion of meaning could avoid the criticisms made by Skinner on the notion of words as symbols. Skinner's rejection of the notion of meaning, and the four consequent points mentioned above, on the other hand, made possible an extremely powerful analysis of how verbal behavior *says things about* objects, events, and so forth, and how the listener comes to understand that (thus shaping and differentiating verbal behavior), not to mention a host of powerful technological applications.

The empirical data supporting the notion of stimulus equivalence led several authors to propose extensions or revisions of Skinner's formulation that include a conception of meaning based on stimulus-stimulus relations. However, Horne and Lowe consider unnecessary the construct of stimulus equivalence and claim that emergent behavior documenting equivalence may be attributed to naming. But if emergent behavior in matching-to-sample situations is indeed verbally controlled, it can be accounted for based on Skinner's verbal operants, especially the tact and the intraverbal, accompanied by self-listening behavior. Then, a notion of meaning and representation, as proposed by Horne and Lowe, seems to be superfluous.

However, it is far from proved that emergent performances in matching to sample are verbally controlled. It is true that data supporting the position against the necessity of naming may be considered relatively "soft," as Sidman (1994) acknowledged. On the other hand, many questions may be raised about data suggesting that language is *necessary* for equivalence (these questions cannot be treated here, but they will probably be made in other commentaries). Thus, as Horne and Lowe acknowledge, we need more data for a definitive answer to this question.

In spite of my considerable disagreements with it, I think Horne and Lowe's essay is a major contribution to the analysis of verbal behavior and stimulus equivalence. It is highly provocative and will certainly succeed in generating debate and research. It also presents an outstanding review of developmental data, especially data that have originated from other theoretical perspectives, and shows how these data can be accommodated within a behavior-analytic approach.

NATURAL CONTINGENCIES IN THE CREATION OF NAMING AS A HIGHER ORDER BEHAVIOR CLASS

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Horne and Lowe spell out in some detail the natural contingencies that may engender the various components of the complex behavior class called naming and cite research by investigators from a variety of developmental perspectives to illustrate how these natural contingencies might work. The operation of these contingencies within natural environments, so as to generate naming from ordinary interactions between children and their caregivers, is important to their case. As was

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the case for Darwinian theory and the selection of species, no elaboration of artificial contingencies to account for natural phenomena is likely to be convincing without evidence that such contingencies are also likely to operate in natural environments (Catania, 1995).

In Horne and Lowe's treatment, naming is an example of a higher order behavior class. Once established as a higher order class in a child's repertoire, it allows for expansions of vocabulary in which the introduction of new words in particular functional relations (e.g., as intraverbals) involves those words in a range of other emergent functions (e.g., tacting, manding, pointing to named objects). Three components create the name relation: listener behavior, determined by the speaking of others, as in orienting toward a shoe upon hearing "where's the shoe?"; echoic behavior that involves producing and hearing one's own utterances, so as to make the speaker a self-listener; and the closing of the circle with naming of objects and events, so that speaker behavior (and other behavior it may occasion) is engendered by nonsocial as well as social stimuli and therefore is no longer initiated solely by others.

One crucial distinction is that between the stimulus and response statuses of both words and objects. Although symmetry seems implicit in the relation between saying a name given an object and indicating the object given its name, the stimulus and response functions of both name and object differ. Without naming, as defined by Horne and Lowe, a heard word is not equivalent to a spoken one and a nonverbal stimulus is not equivalent to a point at it: "the relation between a name and that which it names is fundamentally asymmetrical" (Horne & Lowe, p. 234).

Many issues raised by the account call for separate and extended treatment. For example, given that echoic behavior begins early, in the evolution of native-language phonetic units during infant vocalization, why doesn't it precede the listener behavior with which the account begins (cf. Catania, 1992, pp. 229–231; Risley, 1977)? Also, given the shaping of naming by caregiver behavior, how might that shaping have originated and evolved so as to guarantee its continued selection over successive generations of caregivers (cf. Catania, 1994)? This commentary, however, concentrates on two other issues: the contingencies that determine the classes established by naming, and the status of covert behavior in the account.

There is irony in a scenario that makes naming a product of natural contingencies, because it must then be shown what it is about human behavior that makes those natural contingencies operate for our species when corresponding artificial contingencies are so often ineffective for the behavior of related species such as the great apes. Horne and Lowe have (probably wisely) limited their speculations on this issue. One possibility is that the human capacity to form higher order behavior classes differs from that of other species; another is that humans are unique in their differential sensitivity to properties of their own covert behavior.

Higher Order Functional Classes

Higher order classes are functional classes, or classes with common behavioral functions either produced by similar histories or acquired through emergent relations. For example, if two stimuli are members of a functional class, then the behavior occasioned by one is also occasioned by the other.

Consider as an example Vaughan (1988), in which photographic slides were divided into two arbitrary sets of 20 each and pigeons' pecks were reinforced given slides from one set but not the other. Occasionally the correlation between slide sets and reinforcement was reversed. After several reversals, pigeons began to switch responding from one set to the other after only a few slides. In other words, the common contingencies arranged for the 20 slides in a set made them functionally equivalent, in that changes of contingencies for just a few changed behavior appropriately for all of them. In fact, functional equivalence defines operant classes (as when a rat's lever presses, regardless of topography, become members of an operant class by virtue of their common consequences).

As the Vaughan experiment illustrates, common consequences can create arbitrary functional classes. An example from Horne and Lowe is the word "chair": a name under the control of an arbitrary class of stimuli, established by a verbal community via common consequences for verbal behavior. Such classes cannot be defined by common features. For example, chairs vary in innumerable properties (materials, size, number of legs, etc.). Human categories often involve fuzzy or polymorphous or otherwise arbitrary sets (Plato's essentialism illustrates the antiquity and ubiquity of the problem).

If no common physical features of such classes can be identified, however, any approach must fail that looks to the sampling of stimulus properties, either singly or in combination, to define their formation. For example, acoustic features have no visual properties, so the various auditory forms of the spoken letter "a" can share no common features with the various visual forms of that letter in upper or lower case, print or script. We must look instead at the behavioral processes that created such classes. If the classes include *any* arbitrary components, contingencies involving common consequences are the only source of the consistent features of their members.

On the other hand, not all classes are arbitrary. Common physical properties define many classes (e.g., geometric forms). But perhaps even these classes are ontogenically shaped (within the constraints imposed by the properties of sensory and motor systems and neural organizations selected phylogenically). When class members share physical properties, nonarbitrary functional classes may be created not because of direct effects of those shared properties but rather because, by virtue of those shared properties, all class members are necessarily involved in contingencies with common consequences. For example, running one's hand over a sphere has different consequences than running it over a cube; only in the latter case does one encounter an edge. Thus, what seem to be nonarbitrary natural categories may well be established in the same way as arbitrary ones, over a lifetime of experience with the common contingencies they engender (Catania, 1988, pp. 480–481).

A higher order behavior class includes within it other classes that can themselves function as operant classes, as when generalized imitation includes all the component imitations that could be separately reinforced as subclasses. They may be sources of novel behavior (as in generalized imitation of behavior the imitator had not seen before). Also, higher order classes may sometimes override contingencies operating on their component subclasses (as when one subclass of imitation does not extinguish even though it no longer shares in the reinforcement contingencies maintained for all other members).

Could it be that humans differ from other species in their capacity to form higher order classes? Like any other functional class, a higher order class is held together by the common consequences of its members. What then about cases in which subclasses of higher order classes seem insensitive to their consequences? Does the continuation of members that no longer have common consequences in the class imply that nonarbitrary structural properties define the class? Maybe not, if the class, originally determined by nonarbitrary properties, has a long enough history and has itself become a member of other interlocking higher order and conditional classes within which common consequences continue to operate for all members.

Common consequences superimposed upon arbitrary class membership can create either simple or higher order classes. Higher order classes have been established with nonhumans (as in learning set, where operant classes are defined by relations common to a variety of discrimination problems rather than by the specific stimuli of particular problems; cf. Catania, 1992, pp. 148–150). But perhaps in nonhumans the number of embeddings of such classes is limited. Or perhaps humans are capable of more complex conditionalities involving the overlapping of classes (as when the class "furniture" overlaps with other classes involving varieties of wood, such as oak and teak). Is a comparative behavior analysis needed to address such issues?

Covert Behavior

Another candidate for a crucial human versus nonhuman difference is the capacity to discriminate one's own covert behavior, to which Horne and Lowe occasionally appeal (e.g., "As with the echoic, higher order naming may become increasingly covert and abbreviated in form and may indeed be learned at the covert level of responding, this being reinforced and maintained by a range of consequences," p. 203). But to what is one responding in discriminating one's covert vocalizations, 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

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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

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