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NAMING, THE FORMATION OF STIMULUS CLASSES, AND APPLIED BEHAVIOR ANALYSIS

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The methods used in Sidman's original studies on equivalence classes provide a framework for analyzing functional verbal behavior. Sidman and others have shown how teaching receptive, name-referent matching may produce rudimentary oral reading and word comprehension skills. Eikeseth and Smith (1992) have extended these findings by showing that children with autism may acquire equivalence classes after learning to supply a common oral name to each stimulus in a potential class. A stimulus class analysis suggests ways to examine (a) the problem of programming generalization from teaching situations to other environments, (b) the expansion of the repertoires that occur in those settings, and (c) the use of naming to facilitate these forms of generalization. Such research will help to clarify and extend Horne and Lowe's recent (1996) account of the role of verbal behavior in the formation of stimulus classes.

DESCRIPTORS: naming, stimulus classes, stimulus equivalence, generalization, application of basic research

Sidman's early research on stimulus equivalence in individuals with mental retardation is viewed by many as a prototype for the behavioral analysis of rudimentary language and reading skills (e.g., Baer, 1982; Browder & Lalli, 1991; Mackay, 1991; McIlvane, 1992; Singh & Singh, 1986; Stromer, 1991; Stromer, Mackay, & Stoddard, 1992). Sidman (1971), for example, established new oral reading and comprehension skills, not by direct training, but via expansion of receptive and expressive language skills that the participant had acquired before the experiment. Sidman's work (see summary and discussion by Sidman, 1994) has provided the methodological and conceptual bases for a growing number of studies with implications for applied analyses (e.g., Clarke, Remington, & Light, 1986, 1988; Cowley, Green, & Braunling-McMorrow, 1992; de Rose, de Souza, & Hanna, in press; Haring, Breen, & Laitinen, 1989; Kennedy, Itkonen, & Lindquist, 1994; Lynch & Cuvo, 1995; Maydak, Stromer, Mackay, & Stoddard, 1995; Remington & Clarke, 1993a, 1993b; Stromer & Mackay, 1992, 1993; Stromer, Mackay, Howell, McVay, & Flusser, 1996).

Sidman's research has also raised theoretical issues about the nature of the relationship between verbal behavior and the formation of equivalence classes (Dugdale & Lowe, 1990; Mackay & Sidman, 1984; Sidman & Tailby, 1982; Sidman, Willson-Morris, & Kirk, 1986). For example, suppose that a participant is taught to match pictures and printed words to dictated words, and

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then proves to be capable of (a) matching pictures and printed words and (b) orally naming either the pictures or the printed words. Few would disagree with the suggestion that the emergent matching could have resulted from active or implicit naming (Sidman, Cresson, & Willson-Morris, 1974). In a recent article, however, Horne and Lowe (1996) argue that virtually all such demonstrations of the formation of equivalence classes can be accounted for by the participant's verbal (naming) repertoire, despite some contradictory evidence (e.g., Green, 1990; Lazar, Davis-Lang, & Sanchez, 1984; Sidman et al., 1974, 1986).

The current debate about the role of verbal behavior in equivalence class formation (Horne & Lowe, 1996; commentaries and reply) occasioned the present reconsideration of the practical significance of Sidman's original studies (Sidman, 1971; Sidman & Cresson, 1973; Sidman et al., 1974) and other relevant work on equivalence and verbal behavior. Within that context, we focus on Eikeseth and Smith's (1992) study of naming and equivalence in children with autism because it has both direct and broader implications for applied research. Finally, we consider in detail the issues raised by Horne and Lowe's account of class formation and examine its relevance for applied behavior analysis.

Matching to Sample and Class Formation

Consider the practical objective of establishing all of the educationally relevant behaviors depicted in Figure 1 (Panel 1). Arrows connect the sample stimuli to the comparison stimuli of matching-to-sample tasks (Tasks 1, 3, 5, and 6) and connect these same stimuli to the verbalizations produced by the student (Tasks 2, 4, and 7). On (spoken) name-picture trials (Task 1) with the sample "dog," a response to the picture of a dog is reinforced; when the sample is "cat," a response to the picture of a cat is rein-

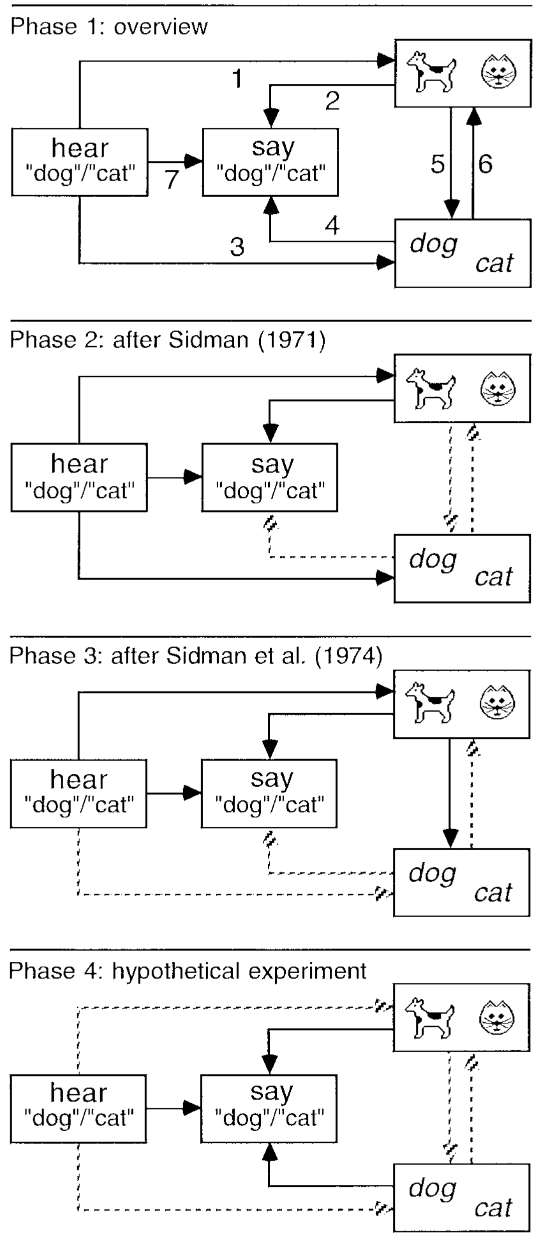

Figure 1. Diagrams representing networks of matching-to-sample and oral naming performances. Arrows connect the sample to comparison stimuli of the matching tasks, and the stimuli to their oral names. Solid arrows represent tasks used during training; broken arrows represent tasks used during testing.

forced. On name-word trials (Task 3), the comparison words *dog* and *cat* are matched to the corresponding "dog" and "cat" samples. In picture-word matching (Task 5), the comparisons *dog* and *cat* are matched to the pictures of the dog and cat, respectively; likewise, in word-picture matching (Task 6), the pictures of the dog and cat are matched to the word samples *dog* and *cat,* respectively. Other tasks involve naming aloud the pictures (Task 2) and printed words (Task 4) and repeating (imitating) the dictated names (Task 7) used during matching trials. Following Skinner's (1957) definitions, Task 2 is tacting and Task 7 is echoic responding (see also the discussion of verbal behavior and matching to sample by Michael, 1985). According to Horne and Lowe (1996), Tasks 2 and 7, together with Task 1 (receptive speech), are the components that, when integrated as a higher order bidirectional relation, constitute naming (see below).

Except for Task 7 (vocal imitation), the tasks involve arbitrary relations between the physically dissimilar stimuli involved in the conditional, selection-based discriminations or between the discriminative stimuli and vocal response topographies of the oral naming tasks. The stimuli in Tasks 1 to 6 could be members of *arbitrary stimulus classes.* Here, we concentrate on the kinds of arbitrary classes articulated in Sidman's (1994) reformulation of *stimulus equivalence classes.* The reader is referred to Sidman's book and other sources (e.g., Hall & Chase, 1991; Horne & Lowe, 1996; R. Saunders & Green, 1992) for discussions of the formal definition of equivalence, the distinction between functional and equivalence classes, and related matters. Arbitrary stimulus classes may be distinguished from *feature stimulus classes* in which the stimuli share physical attributes (McIlvane, Dube, Green, & Serna, 1993; see also the discussion of similarity- and nonsimilarity-based concepts by Wasserman & DeVolder, 1993). In the case of vocal imitation, for example, the stimuli produced by the imitator are physically similar to the stimuli heard. The question, then, is how spoken names, whether heard or said, may participate in arbitrary classes that also involve visual stimuli like pictures and printed words. Because the classes of interest involve spoken names, heard and said, vocal imitation is obviously important and deserves special consideration.

Although Skinner (1957) emphasized the importance of the echoic repertoire, imitation was not prominent in Sidman's original writings (Sidman, 1971, 1977; Sidman & Cresson, 1973; Sidman et al., 1974). Subsequently, Baer (1982, pp. 290–298) recognized that the emergent matching *and* naming in Sidman's original studies were likely because the participants were vocally imitative, and, moreover, the words heard and said may have functioned as members of classes (p. 294). More recently, Sidman (1994, pp. 115–116, see also pp. 305–307) also considered the possibility that the relationship between names that are heard and said may be a reflection of a unitary process involving the repertoires of an individual as speaker and listener (cf. Lee, 1981; Skinner, 1957). As Sidman put it, "it is not far-fetched to propose that in order to be a speaker, one must first become a listener" (p. 116) or, as Horne and Lowe (1996) put it, "the child's listener achievements are . . . a vital stepping stone in the acquisition of verbal behavior . . . [making the transition] from being a listener to the verbal productions of others to becoming a speaker-listener in her own right" (p. 196). We stress that one's long-term and more immediate history of reinforcement will determine whether what is heard is subsequently repeated, and whether what is heard when one speaks then also functions as a stimulus that controls behavior. In contrast, there are circumstances in which listener behavior gives rise to speaker behavior in vocally imitative individuals.

Again, however, the interdependence or bidirectionality of listener and speaker behavior will require an appropriate learning history (for a discussion of relations among visual discrimination and production tasks, see Mackay, 1991).

Sidman's research demonstrated two ways in which a network of naming and matching performances might be established. Sidman's (1971) participant entered the experiment able (a) to match pictures to their dictated names, (b) to name the pictures orally (tact), and (c) to imitate vocally (Figure 1, Panel 2). After being taught to match printed words to the same dictated names, the participant matched pictures and words to one another, and named the words orally (all at about 80% accuracy). Sidman and Cresson (1973) replicated these results with participants who were less proficient on name-picture matching and picture naming (roughly 50% to 75% correct on pretests). Nonetheless, after name-picture and name-word matching were trained, new matching and naming performances emerged (about 67% to 90% correct). Sidman et al. (1974) extended these studies using a different procedure (Figure 1, Panel 3). For example, 1 vocally imitative participant received initial training on name-picture matching. A subsequent picture naming test showed only intermediate accuracy (around 75% correct). Picture-word matching then was taught, and additional tests showed increases in accuracy on word-picture (near 100% correct) and name-word (75% correct) matching tasks. During final tests, word naming also increased over initial levels (about 50% correct).

The emergent matching in these studies permitted the inference of classes of equivalent stimuli, each consisting of a dictated name, a picture, and a printed word. Besides the matching-to-sample training given during the studies, the success of both Sidman's (1971) and Sidman and Cresson's (1973) participants at naming words can probably be attributed to the highly accurate picture naming learned before the experiment began. In general, such outcomes are more likely when stimulus classes that are established by training relate to existing receptive and expressive repertoires. Indeed, Sidman's findings have been replicated across a variety of procedures with participants who possess such entry skills despite considerable variation in developmental status and hearing acuity (e.g., Hollis, Fulton, & Larson, 1986; Joyce & Wolking, 1989; Mackay, 1985; Mackay & Sidman, 1984; Osborne & Gatch, 1989; Stromer, 1996a). Sidman's (1971) and Sidman and Cresson's (1973) name-referent (e.g., picture, word, and symbol) matching procedures have also been used with young children without developmental disorders (Sidman, Kirk, & Willson-Morris, 1985; Sidman & Tailby, 1982; Sidman et al., 1986) and persons with mental retardation (Green, 1990; Sidman et al., 1986). Notably, however, although the participants in these latter studies formed classes, a few of the young children and more than half of the participants with mental retardation did not produce common names for the stimuli during testing. For practical purposes it would be useful to be able to account for why the procedures often failed to yield much oral naming, although it should be mentioned that the studies by Sidman (Sidman et al., 1985, 1986; Sidman & Tailby, 1982) and Green (1990) were not explicitly designed to achieve this outcome. Indeed, the influence of oral naming was minimized; only posttests were conducted because the experiments aimed to demonstrate class formation in the absence of the use of common oral names.

Referent Naming and Class Formation: Eikeseth and Smith (1992)

Figure 1 (Panel 4) illustrates a hypothetical study that examines another way in which a network of matching and naming performance might be established. In this case, naming is directly taught to the participant using imitative vocal prompts. Tests following such training would then assess any changes in the individual's listener behavior using name-picture and name-word matching, in addition to establishing whether printed word-picture (visual) matching had developed. The emergence of the visual matching would permit the inference that the "auditory and visual stimuli [are] related by equivalence" (Sidman, 1994, p. 62).

Eikeseth and Smith's (1992) study lends empirical support to this possibility. In addition, their study tested the generality of several demonstrations of the formation of equivalence classes using only visual stimuli (e.g., Lazar et al., 1984; Stromer & Osborne, 1982; Wetherby, Karlan, & Spradlin, 1983). The analysis of such classes is relevant to educational concerns because the tasks resemble the selection-based visual tasks often used to teach appropriate use of symbols on communication boards (e.g., Remington, 1994; Shafer, 1993) rather than topography-based speech or signing tasks. Eikeseth and Smith's study is also important because the data are relevant to Horne and Lowe's (1996) contention that teaching referent naming may be a "powerful determinant of subsequent performance on equivalence tests" (p. 224).

Overview. Eikeseth and Smith (1992) examined whether children with autism would form classes consisting only of visual stimuli, and, if not, whether a naming intervention might facilitate class formation. The children were aged 3 years 6 months (Trey), 3 years 10 months (Joe), 5 years 6 months (Danny), and 4 years 5 months (Rory). Prior treatment sessions had established generalized identity matching, generalized vocal imitation, and oral naming skills. Age-equivalent scores on the Peabody Picture Vocabulary Test were 2 years 6 months (Trey), 2 years 8 months (Joe), 3 years 7 months (Danny), and <2 years 4 months (Rory), reflecting proficiency in name-picture matching.

Phase 1. Phase 1 examined whether matching-to-sample training with visual stimuli would establish classes. To highlight the potential for teaching functional communication skills, we describe Eikeseth and Smith's (1992) procedure as if they had used pictures of everyday items, printed words, and oral names rather than the abstract Greek symbols actually employed as stimuli. The dog class consists of a picture of a dog and the printed words *dog* and *seb,* and the cat class consists of a picture of a cat and the words *cat* and *tip.* Figure 2 (top left) thus would depict the initial training tasks, matching visual samples and visual comparisons in a two-choice arrangement. Some trials were like matching the words *dog* and *cat* to their respective pictures, whereas others were like matching the words *seb* and *tip* to the same pictures. After the training, blocks of 10 test trials assessed the maintenance of the trained tasks as a baseline, symmetry of the baseline relations (i.e., interchangeability of samples and comparisons), and derived matching (e.g., word-word matching, as in a combined test for symmetry and transitivity; see Sidman & Tailby, 1982). Although oral naming was not assessed on a trial-by-trial basis (e.g., as in Tasks 2 and 4; Figure 1), spontaneous unprompted vocalization that occurred during testing was recorded.

Figure 3 presents test data. Phase 1 began with four blocks of trials that assessed derived matching; all children did poorly, with accuracy ranging from 40% to 60%. Note, however, that Joe's accuracy was 90% for the first block of trials and then declined. On symmetry tests, Trey and Joe passed (scores of 80% to 100% correct), whereas Rory's scores varied from 70% to 90% correct, and Danny's were all 40% correct. In final tests of derived matching, the children performed

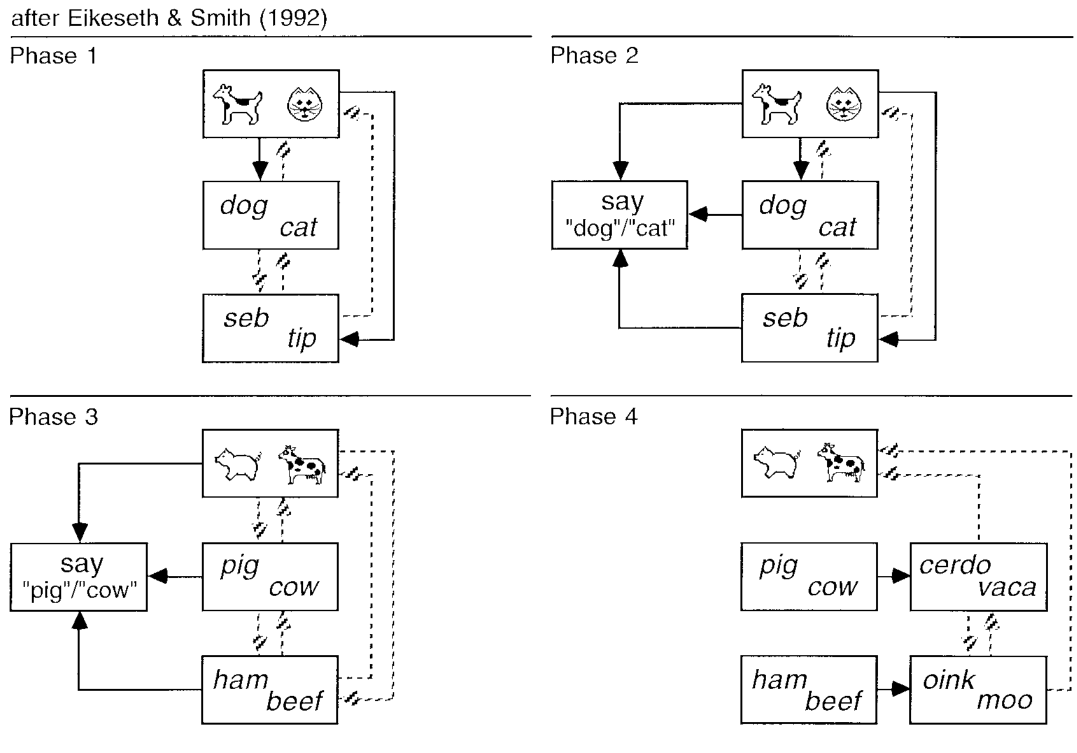

Figure 2. Diagrams representing Eikeseth and Smith's (1992) procedures. Arrows connect the sample to comparison stimuli of the matching-to-sample tasks, and the stimuli to their oral names. Solid arrows represent tasks used during training; broken arrows represent tasks used during testing.

as they did earlier. The lack of background shading for the groups of bars in Phase 1 indicates that none of the children spontaneously produced an audible common name for the stimuli in a potential class while performing the matching tasks during testing. The figure does not include the children's baseline performances that were nearly perfect throughout the study.

Phase 2. Phase 2 involved two training conditions. First, the children were taught to respond to the question "What is it?" by naming orally (tacting) the stimuli used during Phase 1 (Figure 2, top right). The children learned to produce one common name (e.g., "dog") for each of the three stimuli assigned to one potential class (e.g., the picture of a dog and the printed words *dog* and *seb*), and another name (e.g., "cat") for each of the three stimuli assigned to the other class (e.g., the picture of a cat and the words *cat* and *tip*). Next, the children were required to name each stimulus as it was presented for the baseline matching tasks. (Presumably, the cue "What is it?" was dropped during the matching trials.) Blocks of test trials then assessed the baseline (e.g., picture-word matching) and derived matching (e.g., word-word matching). Trey, Joe, and Danny passed the tests of derived matching, but Rory scored only 40% (Figure 3). Although none of the children was required to name the stimuli, all but Danny did so (indicated by background shading on Figure 3). Note, however, that Rory named the stimuli spontaneously and correctly but did poorly on these tests of matching.

Phase 3. In Phase 3, new stimuli (pig and cow classes, Figure 2, bottom left) were used to assess whether teaching a common name

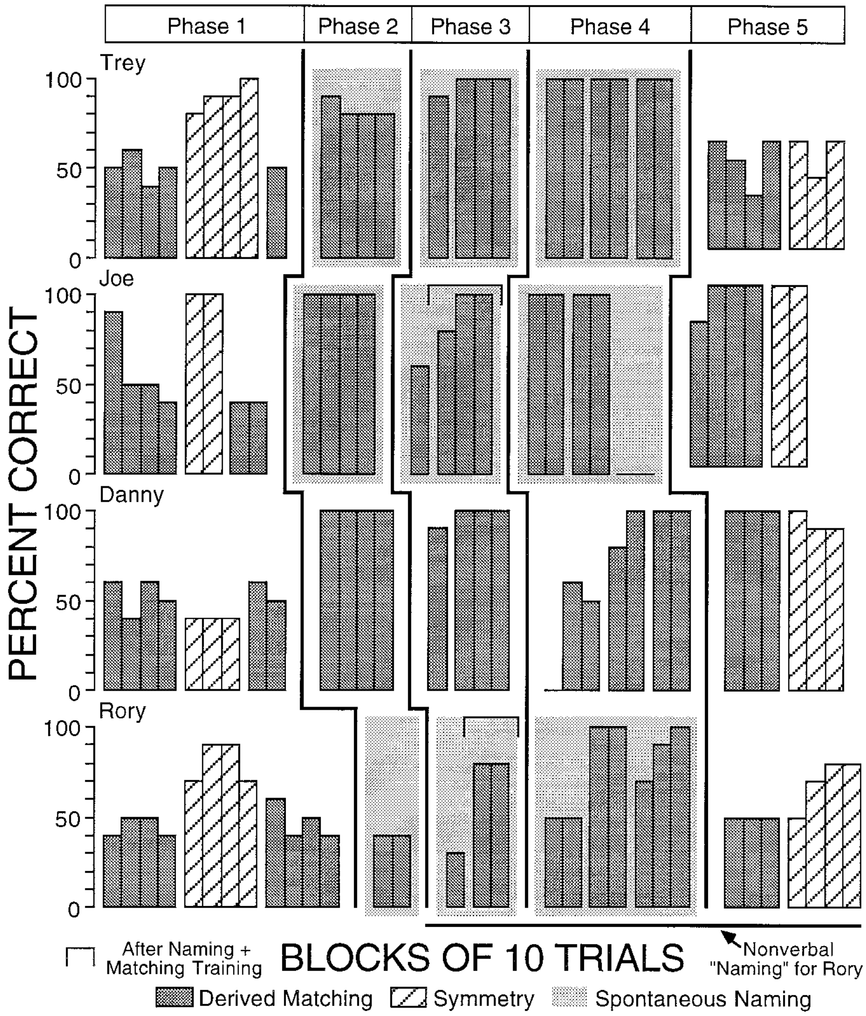

Figure 3. Data based on Eikeseth and Smith's (1992) study. Each bar represents the percentage of correct trials out of 10 given in consecutive blocks of test trials across Phases 1 through 5 (listed at the top). Performances assessed included those on derived matching (solid bars) and symmetry (striped bars) trials. The bracketed bars for Joe and Rory in Phase 3 reflect test performances after training with matching to sample was added to the naming. In Phases 3, 4, and 5, Rory's naming response involved block constructions common to each class of stimuli, instead of the oral names used previously. The background shading denotes that names were produced spontaneously by the child during testing; a white background denotes that names were not produced.

for the stimuli in each potential class would establish the classes. The training involved teaching referent naming (Figure 1), then testing picture-word and word-word matching. Note that because of unsuccessful test results in Phase 2, Rory now tacted the stimuli nonvocally by constructing one of two possible patterns of blocks. In addition, after the initial block of test trials for derived matching, 2 children (Joe and Rory) received additional training before further tests were conducted. This involved adding a matching-to-sample baseline like that used in Phase 2.

Only Trey and Danny unequivocally formed classes following training with common names, as suggested by perfect scores on tests of derived matching (Figure 3). However, as in Phase 2, Joe and Rory received direct training on the visual-visual matching baseline before they passed the tests of derived matching. Also as in Phase 2, Trey and Joe displayed oral naming during testing, Danny did not, and Rory exhibited spontaneous tacting (different block constructions).

Phase 4. Phase 4 (Figure 2, bottom right) assessed whether the stimulus classes established in Phase 3 could be expanded by adding two new stimuli to each class. The procedure involved teaching two new visual matching tasks. For example, one task was like using the words *pig* and *cow* as samples and the new words *cerdo* and *vaca* as the respective correct comparisons. The other task was like using *ham* and *beef* as samples with *oink* and *moo* as the respective correct comparisons. Two kinds of tests for derived matching were conducted: (a) matching *cerdo* and *vaca* and *oink* and *moo* to their corresponding pictures (pig and cow), and (b) matching *oink* and *moo* and *cerdo* and *vaca* to one another.

Only Trey clearly passed all tests for class expansion in Phase 4 (Figure 3). Joe was perfect on the tests that resembled matching *cerdo* and *vaca* to the corresponding pictures of pig and cow and matching *oink* and *moo* to the same pictures. Joe's 0% scores occurred on tests like matching *oink* and *moo* and *cerdo* and *vaca* to one another. In contrast, Danny's low scores occurred on trials like matching *cerdo* and *vaca* and *oink* and *moo* to their corresponding pictures. Note that the 0% scores on some of these tests reflect perfect conditional stimulus control; the children selected the incorrect comparison stimulus on every trial. Danny was the only child who did not name the stimuli during testing, as in Phases 2 and 3.

Phase 5. Phase 5 was like Phase 1, except sets of novel stimuli were used to assess the generality of the performance established earlier. As a result of their experience (i.e., previous history of reinforcement) of common naming, would children now form visual equivalence classes in the absence of explicitly programmed naming? Joe and Danny passed the tests for derived matching and symmetry (Figure 3). Scores for Trey and Rory never reached passing levels, although Rory's symmetry test scores increased from 50% to 80% across four test blocks. No child produced names spontaneously during these tests.

Discussion. Although the 4 children learned the visual matching baselines during Phase 1, all failed the subsequent tests for equivalence. Naming procedures were used in Phases 2, 3, and 4 and, in general, the matching of all children improved. Phase 5 repeated the Phase 1 procedures, and 2 of the 4 children now passed the tests for equivalence. The findings led Eikeseth and Smith (1992) to conclude that "naming may remediate failures to develop untrained conditional relations, some of which are indicative of stimulus equivalence" (p. 123). We agree with this appraisal. The results of Phase 3 support the possibility raised earlier that a speaker's naming may yield relations of equivalence among visual stimuli given the same name. As Sidman (1994) suggests, naming—or any other procedure that produces a partition, classification, or categorization of stimuli—may involve equivalence relations (pp. 416–421). The success of Trey and Danny on the tests for emergent matching in Phase 3 demonstrates such a partition, thus supplying a basis for inferring that the stimuli with the same names were related by equivalence. These findings support the recommendation that stimulus classes should be at the center of future analyses of teaching methods that seek to establish generative and functionally useful expressive verbal skills.

The results of Phase 1 are interesting because the children's naming skills prior to the study might have predicted better performance on the tests of equivalence, despite the unfamiliarity and abstract nature of the Greek letters actually used as stimuli (cf. Horne & Lowe, 1996, p. 224). This notion gains some support from a study by Devany, Hayes, and Nelson (1986), in which young children with mental retardation, who were clinically judged to be "language-able," demonstrated equivalences among visual stimuli with procedures similar to those of Eikeseth and Smith (1992). Further research is needed to determine whether differences between Eikeseth and Smith's and Devany et al.'s findings can be attributed to the nature of the children's disability or to the procedures. Eikeseth and Smith's methods may not have been optimal for class formation (Dube & McIlvane, in press; Stromer & Mackay, in press). For example, positive outcomes might have occurred in Phase 1 if the trained performances had been maintained during posttests, thereby providing a concurrent rather than a remote history of reinforcement with these tasks. The discrepancies between scores on tests for symmetry and derived matching (Trey, Joe, and Rory) and the loss of appropriate stimulus control (Joe) suggest that such procedural refinements may be needed (e.g., Galizio, 1996).

Analysis of the conditions that promote integration of previous and new learning has major educational implications. Eikeseth and Smith (1992) have shown one way in which naming might accomplish such integration, and their results are in general agreement with others involving individuals with mental retardation (K. Saunders & Spradlin, 1990, 1993) and young children (Dugdale & Lowe, 1990). As research clarifies how naming results in positive effects, the nature of tacting responses involved in the formation of stimulus classes may be important (cf. Mackay, 1985). For example, tacting via speech, sign, or even the block constructions used by Rory (and for examples with nonhumans see Manabe, Kawashima, & Staddon, 1995; McIntire, Cleary, & Thompson, 1987) may have an advantage over selection-based tasks because training establishes discriminative control of topographically distinct behaviors by the stimuli that are prospective members of a class (see Mackay, Stromer, & Serna, in press; Stromer & Mackay, in press; Sundberg & Sundberg, 1990).

The naming procedure used in Phase 2 (and in Phase 3 for Joe and Rory) provided two bases for the derived matching that occurred during testing: The comparison stimuli were each related to a common visual sample *and* to a common spoken name. Although the concurrent relationship makes it difficult to identify the source of emergent outcomes, equivalence did not emerge for any of the children in Phase 1 when only visual stimuli were used. Thus, the naming intervention used in Phase 2 may have played an important role in the formation of equivalence classes. The possible facilitative effects of naming identified by Eikeseth and Smith (1992) have practical benefits (see Sidman, 1994, pp. 413–414). For example, as our everyday examples using pictures and words suggest, functionally useful behaviors that typically are viewed as conceptual (e.g., Wasserman & DeVolder, 1993) may be readily established. Further, as suggested previously (see Figure 1, Panel 4), one could examine whether, and when, supplementary training using names would also give rise to new name-referent matching performances. Because an important educational objective is to establish a flexible, bidirectional verbal repertoire (Hayes, 1991; Horne & Lowe, 1996), it would be important to know how receptive and expressive skills can become functionally related to one another. Ample data suggest that such skills may on occasion function independently (e.g., Anderson & Spradlin, 1980; Guess & Baer, 1973; and see reviews by Goldstein, 1993; Stromer & Mackay, in press).

Phase 3 showed that common names alone may provide sufficient basis for the emergence of classes of visual stimuli (Trey and Danny). If the listener (name-referent matching) and speaker (referent naming or tacting) behaviors of these children were functionally interdependent, that might explain both the facilitation effects observed and the emergence of the stimulus classes based solely on a common name (Phase 3). In addition, congruent with these facilitation effects are observations that training with name-referent matching (e.g., Sidman, 1971; Sidman & Cresson, 1973) may be more likely to produce equivalence in children with mental retardation than would training that is entirely visual (Green, 1990; Sidman et al., 1986).

The attempt in Phase 4 to expand current stimulus classes via the use of common names met with mixed success. Only Trey's test results were as expected. The matching displayed by Joe and Danny was particularly interesting because these results were opposite to expectation. These data suggest that the teaching procedure established relations that were incompatible with the formation of the desired classes (e.g., relations between samples and negative rather than positive comparisons; Carrigan & Sidman, 1992). As Sidman (1987) suggested, undesirable sources of stimulus control may be especially likely when two-choice matching procedures are used, as in Eikeseth and Smith (1992). Part of the remedy, then, may lie in the use of three or more comparison stimuli instead of just two.

Spoken names were potential members of the stimulus classes established in Phases 2, 3, and 4 but not in Phases 1 and 5. No naming occurred in Phases 1 and 5. In contrast, Trey, Joe, and Rory always supplied class-consistent names for the stimuli during the tests in Phases 2, 3, and 4, even though the contingencies did not require it. Such spontaneous common naming has been viewed as one (but not the only) basis for success on tests of equivalence by Horne and Lowe (1996, pp. 217–218; and see Stromer & Mackay, in press). However, the relationship clearly was not perfect: There were several instances during Phases 2, 3, and 4 in which Joe and Rory named the stimuli but did not match them in ways that were consistent with the expected classes. Furthermore, Danny succeeded on tests of equivalence in Phases 3 and 5 without overtly naming the stimuli during testing. Likewise, Joe passed the tests in Phase 5 without overt naming. These data are relevant to the supposition that overt common naming is both necessary and sufficient for class formation.

Further Analyses of Stimulus Classes

The stimulus class framework outlined here may be used to examine other functional relations involving verbal events. This section examines (a) how a stimulus class analysis might contribute to the study of ways to promote behavioral generality, particularly (b) how naming and class formation may advance the study of mediated generalization, and (c) how classes may be established by forms of incidental learning.

Feature classes, arbitrary classes, and treatment generalization. Feature stimulus classes often are said to provide the basis for programming the generalization of the effects of intervention (e.g., Albin & Horner, 1988; Horner, Bellamy, & Colvin, 1984; Stokes & Baer, 1977). In contrast, arbitrary classes in general and equivalence classes in particular are mentioned only rarely in this respect (e.g., Goldstein, 1993; Kirby & Bickel, 1988; Mackay et al., in press; Spradlin, 1989; Stromer, 1991). Not surprisingly, therefore, the potential interplay between arbitrary and feature classes has received little attention in discussions of generalization (but see Barnes & Keenan, 1993; Cowley et al., 1992; Fields, Reeve, Adams, & Verhave, 1991; Haring et al., 1989).

The development of feature classes may ensure that stimulus control is not restricted to the particular stimuli used to establish arbitrary matching. For example, Sidman (1971) and Sidman and Cresson (1973) took precautions against producing narrow outcomes by training with several different variations of each of 20 pictures (e.g., pictures of cars included a VW and an MG) in the stimulus set (e.g., Constantine & Sidman, 1975; Sidman et al., 1974). Other research also suggests that the use of multiple instances or sufficient exemplars (Stokes & Baer, 1977) of a potential feature class during training makes the formation of that class much more likely (e.g., Albin & Horner, 1988; Karsh, Repp, & Lenz, 1990; Repp, Karsh, & Lenz, 1990).

Both feature and arbitrary classes are needed for a complete analysis of behavioral generality. For example, consider Sidman's (1971) study in terms of the different preexperimental and experimental situations involved (and see Mackay et al., in press; Stromer et al., 1996, p. 40): Recall that, as a result of an unrecorded history, the student entered the study able to match pictures to dictation and to name the pictures. Because these performances were present on pretests in the experimental setting, it is possible to infer two sets of feature classes. One set included the words dictated by tape recorder, which the participant clearly treated identically to those spoken by people outside the laboratory. The other set of feature classes involved the pictures; the drawings on the response keys were treated as corresponding to their object and picture counterparts outside the laboratory. Without these two sets of feature classes, the student could not have matched and named the stimuli accurately on pretests.

Sidman's (1971) study demonstrates how arbitrary stimulus classes may derive from different learning situations (Stromer, 1991). Recall that after name-word matching was taught, picture-word and word-picture matching emerged in the experimental setting. Similarly, studies by Remington and his associates (e.g., Clarke et al., 1986; and see summary by Duker & Remington, 1991) have shown how preexisting receptive speech (name-picture matching) accelerates the development of expressive signing (referent-signing performance). These studies suggest that the analysis of arbitrary classes may be relevant to the practical concerns of getting novel behaviors to occur appropriately in different settings. Consider the example depicted in Figure 4, in which there are three different settings: Tabletop activities (top) are responsible for teaching name-picture matching and picture naming (e.g., matching the apple and pear to dictation and tacting these stimuli). In addition, a computer located elsewhere (middle) is used to teach the student to match the words *apple* and *pear* to dictation. Given the development of feature and arbitrary classes, the performances acquired in the two settings could give rise to new ones in some other setting, like a store. For example, the student might be able to gather items already written on a shopping list and even ask a store clerk for assistance by reading the names of items on the list. Moreover, if the computer were used to teach anagram spelling (Dube, McDonald, McIlvane, & Mackay, 1991) rather than matching, the student might learn to write the shopping list that is used in the novel matching and naming tasks required at the store (Mackay, 1985; Mackay & Sidman, 1984; Stromer et al., 1996).

The preceding discussion illustrates just a few applications of a framework that involves feature and arbitrary stimulus classes in the analysis of verbal behavior. As additional examples, we note that the notion of equivalence has been given importance in discussions of methods to teach receptive

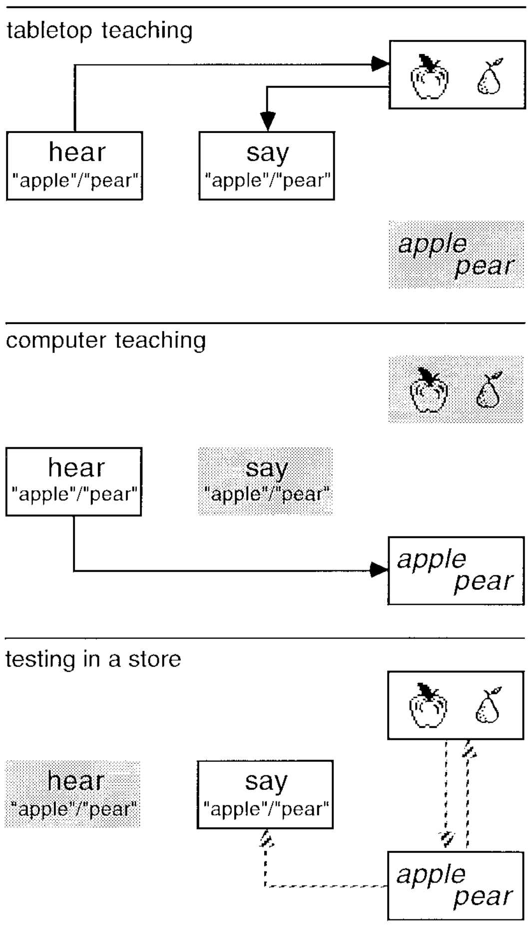

Figure 4. Diagrams representing a hypothetical experiment based on Sidman's (1971) study. Arrows connect the sample to comparison stimuli of the matching-to-sample tasks, and the stimuli to their oral names. Solid arrows represent tasks used during tabletop and computer teaching; broken arrows represent tasks used during testing in a store.

and expressive speech (Goldstein, 1993), augmentative and alternative forms of nonvocal communication (Remington, 1994; Shafer, 1993), and picture reading skills (Lignugaris/Kraft, McCuller, Exum, & Salzberg, 1988) designed to establish adaptive behaviors such as cooking (Johnson & Cuvo, 1981) and cleaning (Wacker, Berg, Berrie, & Swatta, 1985). Clarifying the role of both feature and arbitrary stimulus classes in such instructional pursuits will likely facilitate the development of methods of programming generalization (Albin & Horner, 1988; Kirby & Bickel, 1988; Stokes & Baer, 1977).

Stimulus classes established incidentally. There are major practical benefits when the performances prerequisite for class formation are not taught directly but instead come about incidentally. In one example noted earlier, the reinforcement contingencies in Phase 2 of Eikeseth and Smith's (1992) study permitted two bases for class formation: The comparison stimuli were related to common visual sample stimuli and to the names spoken and heard by the children. Rather than restricted control by one of these stimulus aspects, and even though the reinforcement contingencies did not require it, the visual samples and the spoken names, said and heard, could come to exert discriminative control over comparison selection (cf. Maguire, Stromer, Mackay, & Demis, 1994; Remington & Clarke, 1993a, 1993b). When the procedure engenders such performance, the separate elements of the complex stimuli may function as interchangeable stimuli in classes. Research supporting this possibility has involved college students (Stromer & Stromer, 1990), young children without disabilities (Maguire, Stromer, & Mackay, 1995; Schenk, 1993; Smeets & Striefel, 1994), children with mental retardation (Clarke et al., 1986, 1988), and individuals with autism (Maguire et al., 1994; Remington & Clarke, 1983).

Suppose that a teacher engages students in tabletop activities that are designed to teach children about food groups. One kind of teaching activity involves complex sample stimuli (e.g., saying the word "apple" while holding up a picture of an apple on some trials and saying "carrot" while holding up a picture of a carrot on other trials). The comparisons in both instances are the printed words *apple* and *carrot.* Such procedures may produce broad learning outcomes because each element of each sample may come to exert the same discriminative control. These potential separate outcomes include matching words to dictation and to pictures. In addition, the procedure may give rise to name-picture matching and picture naming.

A second example of incidental learning is based on work showing that differential consequences may become members of classes that include the samples and comparisons to which they have been related (e.g., Dube, McIlvane, Mackay, & Stoddard, 1987; Wolery et al., 1991). For example, students might be taught to match the pictures of apple, pear, carrot, and celery to their corresponding dictated names. Now, in addition to praising correct picture selections, the teacher differentially adds the category name of each food: "Good, the apple is a fruit" or "Good, the carrot is a vegetable." If such consequences were common across training with several stimuli in each category, they could provide the basis for the formation of superordinate classes. Thus, tests would demonstrate that students might match the pictures of apple and pear to "fruit" and the pictures of carrot and celery to "vegetable" without further training. Emergent naming based on the categories might also be possible.

This example suggests how equivalence classes that involve pictures of foods and their printed and spoken names may be brought under the contextual control of category names. The conceptual framework for examining such behaviors already exists (Sidman, 1986), and its potential for addressing applied concerns awaits programmatic study (for a review of some of the laboratory work see Stromer, McIlvane, & Serna, 1993).

A third example is based on the possibility that observational learning may provide the bases for class formation (MacDonald, Dixon, & LeBlanc, 1986). Again, such learning may occur without the support of explicit contingencies. To illustrate, consider a teacher working with a pair of students. One student is taught to match the printed words *apple* and *carrot* and their respective pictures to the dictated names "apple" and "carrot" while a 2nd student merely observes. The 2nd student is then given similar training but with different stimuli (e.g., *pear* and *celery*) while the 1st student observes. The question, of course, is whether each student will demonstrate new performances suggesting that relations among the stimuli were established through the observation of training given to another individual.

Precurrent behavior. Eikeseth and Smith's (1992) data suggest that naming may facilitate the formation of equivalence classes. In principle, this may happen because naming may ensure that the named stimuli function concurrently as discriminative stimuli. Another possibility is that sample naming may function as a mediating response. Indeed, the transfer of behavior trained in the classroom to the community, as exemplified above, may be more likely if a participant learns to use naming as mediating behavior. Such naming is a form of *precurrent* behavior (Skinner, 1968), which is indirectly related to the relevant prevailing contingencies because its occurrence increases the likelihood that some other *current* behavior will be reinforced (e.g., Parsons, Taylor, & Joyce, 1981; Torgrud & Holborn, 1989). The behavioral effects of a mediator, however, may transcend the circumstances of direct training to mediate generalization. Stokes and Baer (1977) suggested that such generalization involved "establishing a response as part of the new learning that is likely to be utilized in other problems as well, and will constitute sufficient commonality between the original learning and the new problem to result in generalization" (p. 361; cf. Kirby & Bickel, 1988, p. 123). Stokes and Baer suggested that verbal behavior has unique properties as a potential mediator, making it easily transported "from any training setting to any generalization setting" (p. 361).

Potential mediators include names that are spoken (Constantine & Sidman, 1975; Gutowski, Geren, Stromer, & Mackay, 1995), signed (Bonta & Watters, 1981, 1983), and written (Stromer et al., 1996). Laboratory studies of such mediators have used delayed matching-to-sample procedures. In delayed matching, the sample stimuli are not presented at the time that responses to the comparison stimuli occur, unlike simultaneous matching, in which the sample stimuli *are* presented at the time that comparisons are selected. For example, in Constantine and Sidman's (1975) study, participants with mental retardation could name pictures, match them to dictation, and match pictures to one another in simultaneous matching tasks. They could also match pictures to dictation in delayed matching. Given the same delay intervals, however, they did not match pictures to pictures. These matching performances then improved dramatically after instructions were given to name each of the picture samples aloud. Without the instructions, accuracy returned to baseline levels. Participants were thus capable of producing mediators that might have bridged the delays and resulted in correct matching. At issue is how to get participants to engage in such naming in the absence of instructions. This does occur (Gutowski et al., 1995), but the learning histories that reliably produce such precurrent behavior are unknown.

Stimulus Equivalence and the Naming Hypothesis: Horne and Lowe (1996)

Applied behavior analysts will find Horne and Lowe's (1996) paper, the commentaries, and reply informative and controversial. Their work is informative largely because it blends data and concepts from theory and research both within and outside the tradition of behavior analysis to chart the course of development of the early naming repertoire of infants and young children without disabilities. It is controversial because Horne and Lowe's appraisal of much of the research on equivalence differs markedly from the views of Sidman (1994) and many other researchers: Horne and Lowe provocatively suggest that some of the methods used to study equivalence are artificial in the sense that they are irrelevant to understanding either the normal development of verbal behavior or the processes by which stimulus classes are normally formed.

Horne and Lowe (1996; see also Dugdale & Lowe, 1990) argue that an individual's naming skills are necessary and may be sufficient for the kinds of performances that emerge in learning situations like those examined by Sidman (1971) and Eikeseth and Smith (1992). Their key contribution is an account in behavior-analytic terms of the development in infancy and early childhood of a "naming relation" that is subsequently responsible for the formation of all equivalence classes, including those involving exclusively visual stimuli. The naming relation represents a synthesis of various expressive *and* receptive abilities, including tacting (Task 2 in Figure 1), echoic responding (Task 7), and receptive speech (Task 1) that are acquired through natural reinforcement processes during the first 24 months of life (see also Dugdale & Lowe, 1990; Hayes, 1991, 1994; Hayes & Hayes, 1992). Horne and Lowe suggest that naming, once fully developed, functions as a higher order bidirectional relation and that "naming *is* stimulus-classifying behavior" (p. 227). Naming relations thus make possible the formation of arbitrary classes, including equivalence classes. Receptive tasks may give rise to what we earlier called feature classes (pp. 195–196). However, in contrast to Sidman (1994), neither receptive nor expressive tasks alone are viewed as the basis of arbitrary classes that involve equivalence relations.

Horne and Lowe (1996, pp. 207–208) describe several tests that might be used to decide whether someone is capable of naming relations. Two of the tests examine the bidirectionality of the relationship between receptive and expressive performances after instances of both are in a child's repertoire. In one such test, new referent naming relations are established directly and then the corresponding name-referent relations are assessed. A second test involves a kind of observational learning or simple pairing procedure (as discussed above) in which, for example, a teacher displays a referent and states its name but no explicit contingencies require any response. Whether the child is then able to perform name-referent matching or referent naming is assessed. Other tests stem from the preceding two and involve stimulus classes, like the feature and arbitrary classes described earlier. An individual who succeeds on such tests has, presumably, satisfied some of the critical behavioral requirements of the naming relation.

Horne and Lowe (1996) adopt the view that the naming involved in mediating stimulus equivalence either may be overt and can be reliably measured as the outcome of a naming test (as for some of the participants in Eikeseth & Smith, 1992), or may remain covert and thus unmeasurable except via self-report or supplementary talk-aloud procedures (Hayes, 1986). Whether overt or covert, verbal behavior is viewed as the critical determinant in the formation of equivalence classes. Horne and Lowe propose that naming may involve the use of common names for members of a stimulus class, as in Eikeseth and Smith, or intraverbal naming (Skinner, 1957), as when a participant provides separate names for each member of the potential stimulus class and then learns a verbal sequence that links them, such as "pig, ham, oink."

For most behavior analysts, the appeal to inner covert processes as an explanation of equivalence class formation raises serious concerns. Consistent with the tenets of behavior analysis, the experimental analysis of the determinants of naming and equivalence relations should emphasize "the environment–behavior relations, such as the contingencies of reinforcement, that give rise to the stimulus control involved" (Stromer, 1996b, p. 250; and see Skinner, 1974, pp. 16–18; Baer, 1982, p. 278). Putative inner causes are normally avoided as explanations, and this approach has often benefited both the practitioner and the scientist because the determinants of behavior, and the methods used to study them, are typically readily accessible to teachers, clinicians, and others for application.

Horne and Lowe's (1996) position, however, is that naming—including covert naming—is indeed the product of a history of reinforcement that is observable, at least in principle, but that once acquired, this repertoire has some transcendent properties. Although many behavior analysts have traditionally preferred to ignore the role of a covert verbal repertoire in modulating operant behavior, Skinner has written extensively on the topic (e.g., Skinner, 1957, especially chap. 19; 1969, 1989). In one sense, Horne and Lowe are arguing that for a verbally competent human, the typical stimulus equivalence task is a problem-solving situation that can be approached through the construction of verbal rules involving the names of stimuli (see Skinner, 1969, for a detailed discussion of rule-governed behavior and problem solving).

What Horne and Lowe (1996, pp. 222–227) term "key tests" of their argument for the necessity of such naming relations are framed here as general experimental questions: (a) Will nonhuman organisms fail tests of stimulus equivalence? (b) Will humans who lack the prerequisite naming skills (naming relations) fail tests of stimulus equivalence? (c) Will teaching participants particular name relations that involve the stimuli used in matching-to-sample procedures be a powerful determinant of subsequent performance on equivalence tests? Horne and Lowe suggest that the existing data so strongly support a positive answer to each question that they propose to fully explain all instances of equivalence with their naming hypothesis, thus disposing of equivalence as an analytic framework. As noted in many of the commentaries on the Horne and Lowe article, this proposal may be premature.

There is general agreement that the search for equivalence, as demonstrated by humans, has eluded most researchers working with nonhumans. The best data to date come from Schusterman and Kastak's (1993) study with a sea lion. Horne and Lowe (1996, pp. 223–224) hypothesize procedural artifacts that may have led to that animal's success on tests of equivalence (but see R. Saunders & Green, 1996) and properly suspend judgment pending replication of the results. However, it is their opinion that it would not be very informative even if such results did hold up in nonhumans because the processes involved would necessarily be contingency shaped rather than verbally mediated, that is, rule governed. The data therefore would be irrelevant to questions concerning the role of verbal behavior in human equivalence. There are at least two possible responses to this position. First, the value of fundamental research in both field and laboratory settings would be diminished if we did not continue to acknowledge the potential relevance of basic behavioral processes that are common across species (Sidman, 1960, pp. 54–56). Second, we should not neglect the possibility that processes that underlie any robust demonstration of equivalence in nonhuman animals may be of importance in understanding the contingencies that actually give rise to rule-governed and other verbal behavior in humans. Moreover, we concur with Mace's (1994) suggestion that the study of equivalence and other kinds of stimulus classes is one of the areas of inquiry that will profit from a wide range of research efforts that include process-oriented laboratory work with both humans and nonhumans as well as intervention studies that attempt to establish socially adaptive behaviors (see also Epling & Pierce, 1986; Hake, 1982). This approach has been just as profitable for behavior analysis as for many other sciences, and, given the complexity and importance of the subject matter, seems most likely to clarify the origins of equivalence and other complex learning phenomena.

Eikeseth and Smith's (1992) data are germane to the proposition of a general relationship between naming skills and performance on tests of equivalence. Horne and Lowe's (1996) position suggests that the children's insufficiently developed verbal skills may have been related to their initial failures on the tests given in Phase 1. However, the nature of those presumed deficits is not at all clear. Nor is it clear what verbal skills were acquired during the naming interventions that might have led to the successful outcomes only for Joe and Danny in Phase 5. Apparently the verbal skills of Trey and Rory were still insufficient. For Trey, this was true even after several sessions of highly accurate matching during the naming interventions. Although there is some evidence that children with mental retardation and autism fail to use available naming skills unless verbally prompted (Clarke et al., 1988; Constantine & Sidman, 1975; Kellas, Ashcraft, & Johnson, 1973), this in itself raises questions about what additional conditions beyond the ability to name are necessary before equivalence emerges. Thus, although the general proposition of a positive relationship between verbal behavior and equivalence is intuitively reasonable and is supported by some findings (e.g., Devany et al., 1986; Horne & Lowe, 1996, p. 224), and although it may serve as a useful guide for applied study, it does not replace the need for fine-grained behavioral analyses of developmental processes and educational and clinical practices.

With respect to potential interventions, Horne and Lowe (1996) stated that Eikeseth and Smith's (1992) study "as a whole shows that common naming can be a powerful intervention in bringing about equivalence even in autistic children" (p. 225). Later, they concluded, "The possibility that naming is both necessary *and* sufficient for success on equivalence tests is supported by evidence, collected from several studies, that naming interventions are highly effective in bringing about such success" (Lowe & Horne, 1996, pp. 332–333). In contrast, the data in Figure 3 suggest that (a) Eikeseth and Smith's results were not robust, showing differences across children; (b) alternative explanations of the improvements in test performances have not been ruled out (e.g., Carr & Blackman, 1996; Galizio, 1996; McIlvane & Dube, 1996); and (c) the nature of the naming skills that may be involved in passing the tests for equivalence require further clarification (e.g., Fields, 1996; Lowenkron, 1996; Pilgrim, 1996; Remington, 1996; K. Saunders & Spradlin, 1996; Stromer, 1996b).

Part of the clarification requires the recognition that the use of common names is but one form of verbal behavior upon which equivalence may be based (e.g., Horne & Lowe, 1996, pp. 218–219; and see Stoddard & McIlvane, 1986). Horne and Lowe's discussion of intraverbal naming, particularly when considered in the context of an analysis of feature and arbitrary classes, suggests interesting applied and basic research possibilities that would extend the few studies that have used participants with developmental disabilities (Braam & Poling, 1983; Luciano, 1986; Watkins, Pack-Teixteira, & Howard, 1989). For example, a child who, when asked to name "school things," says "bus, chalkboard, globe" may be exhibiting intraverbals (Braam & Poling, 1983). The complexities and payoffs of analyses of intraverbals grow when one considers Sidman's (1986, 1994) discussions of higher order classes. As noted earlier, for example, first-order equivalence classes involving pictures, words, and names of foods might be brought under the contextual or second-order control of category names ("fruit" and "vegetable"). The range of emergent naming performances could include item naming as well as category or intraverbal naming. Examples here include saying "apple, pear, orange" when asked to "name some fruit," and saying "carrot, celery, broccoli" when asked to "name some vegetables." Studies using higher order procedures are important because they highlight the relevance of equivalence for applied and basic research on category learning (e.g., Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) and suggest ways of analyzing contextually controlled verbal repertoires (e.g., Hall & Chase, 1991; Mackay et al., in press; Silverman, Anderson, Marshall, & Baer, 1986).

Horne and Lowe (1996) accept that naming alone is not a panacea for difficulties a participant might have on tests of equivalence: "Whether or not naming is established in ways that facilitate the passing of equivalence tests is dependent on the particular training procedure used" (p. 217). They also said that "intraverbal naming can work for or against success on tests of stimulus equivalence depending on whether or not the intraverbal sequences that are formed before such testing are congruent with experimenter-defined classes" (p. 226). These conclusions are consistent with the thematic focus of the present paper: whether the names heard or said participate in classes will require a relevant prior and current history with contingencies of reinforcement. As shown by Eikeseth and Smith (1992), for example, a naming intervention may fail to facilitate class formation as often as it succeeds (and see Stromer & Mackay, in press), justifying the conclusion that naming may or may not suffice, depending on other, unknown factors. With respect to such considerations, Horne and Lowe's commitment to a hypothesis that ascribes special status to covert verbal events has theoretical significance, but its practical utility remains to be clarified. Postulating a functional role for covert naming in matching performances that show equivalence offers no simple, immediate, or complete solutions to the practical problems of designing effective educational intervention procedures. From a broader perspective, however, a better understanding of the acquisition of naming as a developmental process has important implications for the remediation of language deficits. In addition, Horne and Lowe's analysis implies that educational interventions may be more effective if delivered in a structured sequence, with entry to higher levels based on appropriate testing for prerequisite lower level skills, of which naming is the most critical.

In keeping with the idea that naming is a necessary prerequisite of equivalence, Lowe and Horne (1996) write, "If it could be shown that any nonverbal human (e.g., young infant) or other human subject who did not, for some reason, name stimuli or use verbal rules during a study could pass Sidman's tests, then this alone would show that verbal behavior was not necessary for success" (pp. 331–332). In fact, one could comfortably argue that such evidence already exists (e.g., R. Saunders & Green, 1996; Sidman, 1990; Stromer, 1996b; Stromer & Mackay, in press), at least if only overt naming is taken into account. For example, Joe and Danny in Eikeseth and Smith's (1992) study passed the tests for equivalence among visual stimuli (Phase 5) without supplying oral names. Also, reconsider the 4 participants in Sidman et al. (1986) and the 5 participants in Green (1990), all with mental retardation, who learned the name-referent matching baseline and eventually succeeded on tests of equivalence. Only 4 of these 9 participants passed the referent naming tests. For the other 5, listener behavior (name-referent matching) brought about equivalence classes apparently in the absence of the corresponding speaker behavior (referent naming). Moreover, there is little if any empirical foundation to suggest that individuals with autism and mental retardation would have been able, if tested appropriately, to supply a verbal rule that accounted for their emergent matching. For example, it is unlikely that intraverbal naming exists in the repertoires of participants with autism and mental retardation without being explicitly taught (Braam & Poling, 1983; Luciano, 1986; Watkins et al., 1989; see also Sidman, 1990).

To uphold the theory that naming is necessary for positive results on tests of equivalence, Horne and Lowe (1996) might respond to Sidman et al.'s (1986) and Green's (1990) data by questioning whether the tests used to measure naming produced false-negative outcomes. To the suggestion that participants with autism or mental retardation lacked intraverbal skills, Horne and Lowe might point out that the intraverbals required need be no more than repeated name pairs and that what is important "is not that all performance on matching-to-sample tests is necessarily self-instructed or verbally controlled but that, incontrovertibly, at least some is" (Lowe & Horne, 1996, p. 329). Furthermore, Horne and Lowe might emphasize that studies with very young children (p. 224) and those with the most severe language impairments (e.g., Barnes, McCullagh, & Keenan, 1990; Devany et al., 1986; Eikeseth & Smith, 1992) have, so far, almost always failed to find evidence of equivalence relations (cf. Stromer & Mackay, in press).

What is incontrovertible is that the publication of Horne and Lowe's (1996) article has set the stage for much-needed further analysis of stimulus classes that involve verbal events. Important contributions to the analysis will come from researchers who are working on the practical concerns of establishing rudimentary language and communication skills in individuals with severe intellectual limitations. Both basic and applied science will benefit from the thorough study of the conditions under which naming—whether spoken, signed, written, or constructed—participates in the formation and elaboration of feature and arbitrary stimulus classes.

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