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COMMENTS ON SIDMAN'S *REMARKS*

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I am deeply honored by the invitation to comment on Murray Sidman's *Remarks* (Sidman, 1976, 1977a, 1977b, 1978, 1979, 1981, 2011). At the same time, I have to agree with Sidman's own comments in one of those remarks: "It is difficult to add anything cogent that has not already been said" (Sidman, 1976, p. 279). In the present commentary I will mention two of the issues I have found important in my experience in behavior analysis: stimulus control and experimental design.

Sidman mentions matching-to-sample and conditional discrimination in several of his remarks (Sidman, 1978, 1979, 1981, 2011), as well as symmetry (Sidman, 1981). Hence, I find it appropriate to comment on issues regarding stimulus equivalence. My interest in stimulus equivalence research was first kindled in 1982. I was made aware of the *JEAB* articles published by Murray Sidman and coworkers when I was a graduate student. The content of the articles really fascinated me, and it was like opening a door to a new world. We had a number of seminars at the university about the generativity of language. I remember that one of the professors argued that for a behavior analytic explanation of language to be valid, people would have to live for over 1000 years because of the need to reinforce every one of their verbal utterances. We know that the professor's comments indicate an incomplete understanding of a behavior analytic explanation of language, but those comments nevertheless highlight an important point: How do people come to say or do things they have never said or done before? So for me the most fascinating aspect of stimulus equivalence was the emergence of relations that have not been directly trained.

Sidman's studies have not only had a great impact on basic research, but also on applied research and practical demonstrations of how to use stimulus equivalence training to teach skills. Interestingly, Sidman's studies in the 1970s were concerned with teaching reading skills (or, more precisely, reading with comprehension) to persons with developmental disabilities. After 1982, research in stimulus equivalence was largely concerned with basic research questions such as, for example, identifying the variables and relations that were responsible for the development of stimulus equivalence. However, lately a large number of studies have shown the importance of stimulus equivalence training in establishing many different skills with many different types of participants. The most fascinating

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aspect of the training procedures is that you train only a certain number of relations, and then you will get a number of other relations for free.

Many readers will recognize that Sidman and Tailby (1982) defined stimulus equivalence as responding that exhibits the properties of reflexivity, symmetry, and transitivity. As pointed out by Sidman, this definition is actually an interpretation, in the sense that you do not observe stimulus equivalence directly. In the same way, Sidman mentioned that the existence of stimulus control itself is an inference (Sidman, 1979). He writes that

> the equivalence is neither a theoretical entity nor an entity or process that is beyond observation. My own theorizing has been directed not so much at an explanation of equivalence relations but rather, at the formulation of a descriptive system—a consistent, coherent, and parsimonious way of defining and talking about the observed phenomena. (Sidman, 1994, p. 536)

I have always taken Sidman's words to mean that stimulus equivalence ultimately refers to a description of environment–behavior relations as shown in the individual's behavior.

Three different training structures have commonly been used in training the conditional discriminations as prerequisites for testing for stimulus equivalence: (a) Linear Series (hereafter abbreviated as LS; train AB and BC, then test for BA, CB, AC, and CA relations); (b) Many-to-One (hereafter abbreviated as MTO; train AC and BC, then test for CA, CB, AB, and BA relations); and (c) One-to-Many (hereafter abbreviated as OTM; train AB and AC, then test for BA, CA, BC, and CB relations). According to existing definitions, it is not possible to have a "clean" transitivity test in any other structure than the LS training structure because the AB test following MTO or the BC test following OTM training constitutes a combined test for transitivity and symmetry. I would like the hear more about Sidman's thoughts on the definition of stimulus equivalence and the possibility of a "clean" transitivity test.

A number of studies have explicitly examined the effects of the different training structures. One intriguing finding is that LS training is the least efficient training structure in producing stimulus equivalence with a simultaneous training and testing protocol. MTO training (AC and BC) and OTM training (AB and AC) differ from LS training (AB and BC) in many respects. However, an important question is why LS training should require a greater number of trials for the first trained relation to develop, and, subsequently, equivalence. It would be interesting to determine if the number of training trials using LS, MTO, and OTM training structures is actually controlled for in studies that have reported differences in how readily equivalence develops.

Sidman (1994) discusses how the effects of different training structures have been explained (it is interesting to note that the front page of Sidman, 1994, is the OTM training structure). As Sidman points out, the effects cannot be because of directionality per se:

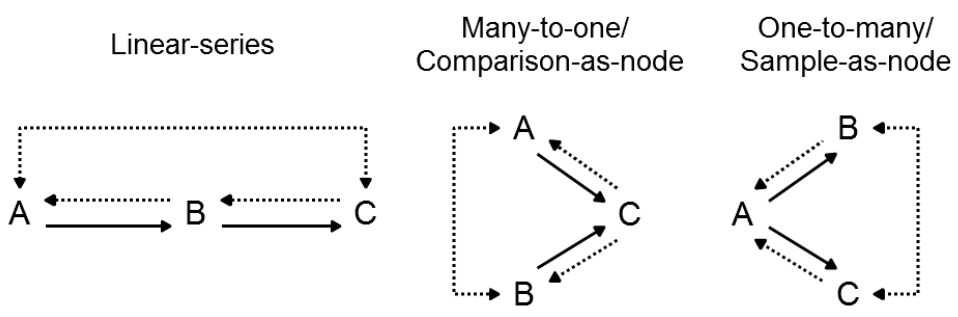
> The direction in which arrows points in our laboratory notebooks makes no contact with our experimental subjects. The emphasis on a seeming directionality is an instance of theory not only becoming divorced from reality but actually keeping us from looking at factors in the historical or current environment that might underlie different outcomes of the two paradigms. (p. 526)

I would enjoy hearing Sidman's comments on whether different processes are associated with these three different training structures, given that the different training structures seem to require different numbers of training trials to produce equivalence.

Sidman (1979) discusses the controlling functions of stimuli in matching-to-sample experiments. Later, and related to the issue of directionality, Sidman (1994) discusses the differences between MTO and OTM training based on the number of times the functions of stimuli shift, as stimuli move from being samples during training to being comparisons during testing and vice versa. The number of times the functions of stimuli shift is also potentially important because discrimination between samples requires a successive discrimination, whereas discrimination between comparisons requires a simultaneous discrimination. The number can be expressed as C(M-1), where C is the number of classes and M is the number of members. Therefore, the number of times the functions of stimuli shift from sample to comparison and from comparison to sample may differ between MTO and OTM, depending on the untrained relation for which we are testing.

For example, suppose we consider conditional discrimination training followed by symmetry testing to illustrate this point. MTO training might involve directly training relations between AC stimuli and between BC stimuli, and then testing for untrained relations between CA stimuli and between CB stimuli (see figure below). Readers will note that stimulus functions shift during C<u>A</u> and C<u>B</u> testing, where the underlined letters indicate the stimuli that change from sample to comparison during testing.

Training Structures: Example with Three Members



Solid arrows indicate trained relations; dashed arrows indicate tests for responding that exhibits untrained relations of symmetry, transitivity, and equivalence.

Similarly, OTM training might involve directly training relations between AB stimuli and between AC stimuli, and then testing for untrained relations between BA stimuli and between CA stimuli. Here, stimulus functions shift during BA and CA testing, where the underlined letters indicate the stimuli that change from comparison to sample during testing.

For equivalence testing, however, the number of stimuli that shift from sample to comparison and vice versa is the same for MTO and OTM. For MTO, testing for untrained relations between AB stimuli and between BA stimuli will involve shifts from sample to comparison and vice versa. The underlined letters indicate the stimuli that change from sample to comparison during testing. For OTM, testing for untrained relations between BC stimuli and between CB stimuli will involve shifts of stimulus function, where the underlined letters again indicate the stimuli that change from comparison to sample during testing.

As reviewed above, the number of times the functions of stimuli shift from sample to comparison and from comparison to sample is not the same with MTO as with OTM when testing for symmetry. To understand the effects of the training procedures for the development of equivalence, ideally we would like to equate the number of shifts (a) between sample and comparison, and (b) between comparison and sample for the procedures.

Despite the differences I note above, I cannot see that the data in general are very much different on the symmetry tests depending on the training structure used. Nevertheless, I would enjoy hearing from Sidman as to whether the number of times the functions of stimuli shift across training and testing is an important consideration in the development of equivalence.

Finally, Sidman (1981) writes about how important it is to be clear about the purpose of an experiment before introducing the experimental design. In regard to experimental design, I think it is interesting to note that a number of studies in the area of stimulus equivalence research are group design studies or experiments without convincing experimental control. One reason for this, I think, is that within-subject manipulations can be difficult because of an order effect: Do participants learn something in one condition that influences their performance in the next condition? I would like the hear more about Sidman's thoughts on using group design studies to investigate stimulus equivalence.

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