Journal of the
Experimental Analysis of Behavior

JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 2014, **101,** 152–155 NUMBER 1 (JANUARY)

MEANING IS MORE THAN ASSOCIATIONS: RELATIONAL OPERANTS AND THE SEARCH FOR DERIVED RELATIONS IN NONHUMANS

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Defining Perceptual-, Relational-, and Associative-Based Concept Learning

Zentall et al. distinguish between concept learning based on physical similarity (perceptual-based), relational-based in terms of relations between and among events, such as that seen on tests of same and difference responding, as well as associative concept learning in which the particular arbitrary stimuli are related along nonformal lines. At stake here is the necessity and usefulness of distinguishing between perceptual- and relational-based concepts because both involve responding controlled by the formal properties of the relata.

According to RFT, it may be appropriate to consider perceptual- and relational-based concept learning as instances of nonarbitrarily relational responding, and associative-based concept learning as instances of arbitrarily applicable relational responding (Dymond & Roche, 2013; Hayes, Barnes-Holmes & Roche, 2001). Nonarbitrary relational responding involves responding based on the nonarbitrary or formal properties of the stimuli being related (e.g., such as the color or shape [perceptual similarity] of the stimuli; see Giurfa, Zhang, Jenett, Menzel, & Srinivasan, 2001; Stewart & McAlwee, 2009). On the other hand, arbitrarily applicable relational responding is “based not on any nonarbitrary or formal relations between the stimuli being related but on aspects of the context that specify the relation such that the relational response can be brought to bear on any relata regardless of their nonarbitrary properties.” (Stewart & McAlwee, p. 312). In this way, both nonarbitrary applicable relational responding and arbitrarily applicable relational responding involve responding to one event in terms of another and are generalizable to novel events.

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doi: 10.1002/jeab.57

In Zentall et al.’s taxonomy, then, same and difference responding constitutes an instance of nonarbitrary relational responding, along with behavior classified as perceptual-based, while associative concept learning such as that seen on arbitrary match to sample (MTS) tasks may be considered examples of arbitrarily applicable relational responding. Approaching concept learning in this way may prove useful when investigating emergent relations in nonhumans, the interrelationship between nonarbitrary and arbitrary relational responding and the contextual factors responsible for facilitating the transition between types of relational responding.

Symmetry Training?

Relational frame theory posits that a plausible and empirically testable method of facilitating the emergence of derived relations in nonhumans is to provide a history of reinforced (bidirectional) relational responding with multiple stimulus sets before testing for generalized relational control with a novel set of stimuli. Zentall et al. briefly address this possibility in the context of what they refer to as *symmetry training*, which involves bidirectional training (i.e., A–B and B–A) with two stimuli and then training a further discrimination with a novel stimulus (i.e., B–C) before a potential emergent relation is tested between the remaining ‘symmetry-trained stimulus’ and a new stimulus (i.e., A–C). In this way, the purpose of symmetry training is actually to make the stimuli functionally equivalent and to yield an emergent relation only after a new discrimination has been trained to one member of the functional class.

Zentall, Clement and Weaver (2003) tested this in an experiment with pigeons. Symmetry training used a successive discrimination procedure to train A–B and B–A relations, with completion of the response requirement to the second stimulus always followed by food, and trials were interspersed with simultaneous matching-to-sample (MTS) trials to train B–C relations. A training criterion was only applied to MTS performance and required a minimum of 90% correct responding on each of the sample–comparison relations (i.e., B1–C1 and B2–C2). Once met (which, incidentally, took the eight pigeons an average of 4300 trials), a single testing session was conducted in which the same successive stimulus presentations occurred (i.e., A–B and B–A) along with MTS tests for emergent A–C relations.

Zentall et al. (2003), in a feature not shown in Zentall et al. (2013) or Table 8, designated a comparison as correct if it was consistent with "the presumed substitutability of the successive stimulus–stimulus pairings established in training (consistent group); [while] for the remaining pigeons (inconsistent group), those contingencies were reversed" (p.389). The predicted facilitative effects of this symmetry training procedure were inferred on the basis of successful transfer performance of the consistent group (*M*: 61.9%) over the inconsistent group (*M*: 39.5%) on the new A–C relation.

There are several implications of these procedures for understanding emergent relations in nonhumans. First, all test trials in Zentall et al. (2003) were presumably still reinforced, which makes interpretation of the emergent basis of the performance difficult. Second, it is unclear what the intention was of defining groups, seemingly post hoc, as consistent or inconsistent on the basis of responses made to the predicted correct and incorrect comparisons during the single block of MTS trials. The MTS comparisons were always yellow and blue colors, selections of which were correct or incorrect depending on the contingencies of the previous successive discrimination trials. Thus, it is unclear whether or not the consistent/inconsistent distinction was simply a method of classifying test responses. As a result, there appears little basis for predicting greater accuracy in one 'group' or another on acquisition of the novel A–C trials or what the potential facilitative effects of symmetry training is intended to be. Finally, other studies on functional equivalence have yielded better outcomes using MTS-based procedures without the need for symmetry training or combined successive and simultaneous discrimination tasks (e.g., Kastak, Kastak, & Schusterman, 2001). On closer inspection then, the implications of *symmetry training* in facilitating emergent relations in nonhumans remains unclear.

Zentall et al. (2013) do not explicitly address alternative accounts of these data but an RFT interpretation highlights the nature of the training involved and suggests alternative tests of the predicted facilitative effects of symmetry training. For instance, rather than testing effects on the acquisition of functional equivalence using combined successive and simultaneous discrimination procedures, an account based on RFT would predict facilitative effects of bidirectional training with multiple exemplars (e.g., train A–B, B–A, and C–D; test D–C) within the same procedure and with the same relational response when tested across novel stimulus sets. The basis for this prediction is relatively simple: according to RFT, arbitrarily applicable relational responding such as that seen on tests for symmetry is a form of relational operant behavior, established early in the history of the organism, and acquired across multiple stimulus sets or learning exemplars before being applied under relevant contextual control to a novel, tested set (Stewart, McElwee, & Ming, 2013). If relational responding is first found to be absent, RFT predicts a potential facilitative effect when the relational response is trained and tested with many different exemplars, such that the response is abstracted, arbitrarily applied, or generalizes to a novel set without further training (Barnes-Holmes, Barnes-Holmes, Smeets, Strand, & Friman, 2004; Berens & Hayes, 2007; Vitale, Barnes-Holmes, Barnes-Holmes, & Campbell, 2008; Whelan, Walsh, Horgan, May, & Dymond, 2014).

Currently, the only supportive evidence available for the RFT account of the role of multiple-exemplar training in facilitating symmetry in nonhumans comes from an equivocal and as yet unreplicated study by Schusterman and Kastak (1993). In that study, Schusterman and Kastak observed successful symmetry test performance in a sea lion after training with six exemplars and testing with another six sets. This occurred after the sea lion had failed the original symmetry test (i.e., testing for B–A after A–B training) and was achieved after the B–A relational responses were trained with some problem sets and then tested with others. The sea lion met criterion during the additional tests on the first test trial and also passed C–B probes (after B–C training) more readily and without the need for further multiple-exemplar training, before going on to show evidence for both transitivity (A–C) and equivalence (C–A) relations.

The symmetry training procedures used by Schusterman and Kastak (1993) differ considerably from those described earlier by Zentall et al. (2003). However, from an RFT perspective, in the latter design nothing is derived unless accurate performance on C–A trials is also seen. Such tests were not undertaken, but other permutations are certainly possible such as incorporating a test of C–B relations after A–B, B–A, and B–C training and testing within the successive discrimination procedure. In the RFT sense, symmetry training would consist of bidirectional conditional relation training across multiple stimulus sets before a critical test is conducted with one relation of a novel set (i.e., H–G after G–H, F–G, G–F, E–F, F–E, etc.). Hayes (1989) made a similar point: "One possible approach [to demonstrating derived relations in nonhumans] may be to provide an extensive reinforced history with symmetrical relations. After hundreds or thousands of directly reinforced symmetrical relations, equivalence may emerge" (p. 391). However, a comprehensive test of this account has yet to be conducted.

This highlights the operant nature of RFT (Hayes & Barnes-Holmes, 2004) and describes testable predictions based on the account that can be readily applied to research with nonhumans. For instance, what is the nature and extent of the bidirectional multiple exemplar training needed before relational operants emerge in tests for symmetry in nonhumans? What is the history required before performance becomes asymptotic? Is MTS required for multiple exemplar-like effects? What stimulus features and response requirements are better at facilitating potential savings in training and/or testing outcomes (e.g., Bhatt & Wright, 1992; Grainger, Dufau, Montant, Ziegler, & Fagot, 2012; Katz, Wright, & Bodily, 2007; Wright, Cook, Rivera, Sands & Delius, 1988)? Does the use of response requirements consistent with nonhumans' evolutionarily acquired ability to find and consume food, such as digging and scratching by pigeons (e.g., Wright & Delius, 1994), facilitate the acquisition and emergence of relational responding compared to key pecking at visual stimuli? Just how generalizable is relational responding and for how long can it be maintained? And, are the results of Schusterman and Kastak (1993) replicable with other species? It is imperative that these and other empirical questions be tested in innovative research designs with nonhumans.

Associating with Associative Symmetry?

Zentall et al. (2013) use the terms "associative symmetry" and "symmetry" interchangeably but prefer the former because of its apparent emphasis on associative learning processes (which are themselves undefined) and rightly reject a definition of symmetry based on nonarbitrary (perceptual-based) features. What then is added by the term "associative symmetry", which is procedure-bound with successive MTS? If symmetry relations are said to refer to specific instances where the trained and tested relations are bidirectional, what precisely defines a relational response as an instance of "associative symmetry"? Here, RFT proposes the term "mutual entailment" as a generic alternative to symmetry that captures both symmetry relations and those instances where the trained and tested relations differ, such as with comparative relations (i.e., A is more than B, which derives B is less than A; Munnelly, Dymond, & Hinton, 2010). The emphasis on multiple stimulus relations other than symmetry, equivalence or sameness relations is a defining characteristic of RFT, and one that sets it apart from other accounts that are, admittedly, more limited in scope (Sidman, 2008). While Zentall et al. are silent on the role of multiple stimulus relations, their claim that findings on associative symmetry contradict RFT's contention that symmetry emerges via a reinforced history with multiple exemplars requires further empirical scrutiny.

Conclusion

In 2005, Frank and Wasserman suggested, "we obviously are still a very long way from having methods for producing robust symmetrical responding in nonhuman animals without providing exemplar training." (p.149). Indeed, further innovative research is needed to thoroughly test these and other predictions made by RFT about the histories involved in relational operant behavior. The impressive program of research described by Zentall et al. (2013) in their erudite review will inspire and motivate further work aimed at testing the relative merits of RFT and other accounts of emergent relations. But, until then, we need a great deal more evidence before it can be definitely concluded that nonhumans have shown stimulus equivalence.

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Received: October 24, 2013
Final Acceptance: October 24, 2013