Language Generativity, Response Generalization, and Derived Relational Responding

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Language generativity can be described as the ability to produce sentences never before said, and to understand sentences never before heard. One process often cited as underlying language generativity is response generalization. However, though the latter seems to promise a technical understanding of the former at a process level, an investigation of definitions and approaches to the term ''response generalization'' that appear in the literature suggests that it does not do so. We argue that a more promising candidate for the role of key process underlying language generativity is derived relational responding. We introduce the latter concept and describe empirical research showing its connection with language. We subsequently present a relational frame theory (RFT) conceptualization of derived relations as contextually controlled generalized relational responding. We then review a series of recent studies on derived manding in developmentally delayed children and adults that arguably demonstrate the applied utility of a derived relations-based approach with respect to the phenomenon of generative language.

Key words: language generativity, response generalization, derived relational responding, relational frame theory, manding

For almost 50 years, basic and applied behavior analytic researchers have been concerned with developing procedures for teaching language to children with autism and other developmental disabilities. Furthermore, in the last few decades, in particular, there has been considerable success and progress in this endeavor with many outcome studies demonstrating significant gains in language and IQ scores (e.g., Lovaas, 1987; McEachin, Smith, Lovaas, 1993; Remington, Hastings, Kovshoff, degli Espinosa, Jahr, Brown, Alsford, Lemaic, & Ward, 2007; Wilczynski & Christian, 2008). Despite this record, however, in one area—language generativity—success has been more elusive.

LANGUAGE GENERATIVITY

Language generativity might be described as the ability to produce sentences never before said, and to understand sentences never before heard—to ''speak with meaning,'' and ''listen with understanding'' (Hayes, Barnes-Holmes & Roche, 2001, p. 3). It is fundamental to the development of fully functional communication. Furthermore, social interaction requires an increasingly complex repertoire in this respect on the part of the child. Thus, the development of this phenomenon is critical. However, despite its importance, establishing generative language in child populations in whom it is deficient has proven to be a major challenge. For example, in the case of children with autism, rote, inflexible responding is a persistent problem in spite of early intensive behavioral intervention (EIBI; Greer & Ross, 2008; Lord & McGee, 2001).

Within the field of EIBI, the appearance of novel responding is typically ascribed to processes of generalization. According to Lovaas (1981), for example, ''[s]ome degree of generalization, be it stimulus or response is critical for successful teaching. You have to get some changes 'for free' because you cannot build all behaviors in all situations'' (p. 110). As another example, Williams and Williams (2010) suggest ''stimulus and response generalization are primary reasons why human beings do not have to be taught every response and under every circumstance

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in which the response should occur'' (p. 85). The term ''generalization'' is, of course, also applied in the more specific context of the emergence of novel verbal responding (e.g., Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007; Koegel, Camarata, Valdez-Menchaca, & Koegel, 1998; Sweeney-Kirwan, 2008; Williams & Williams, 2010). For instance, Sweeney-Kirwan (2008) refers to the objective of intraverbal webbing procedures as being ''to teach advanced intraverbal skills which will facilitate response and stimulus generalization and avoid rote responding.''

RESPONSE GENERALIZATION

The phenomenon of language generativity typically involves novel responding that was not trained, and thus it has been linked more specifically with response rather than stimulus generalization. According to Lovaas (2003), for instance, ''we had hoped that once the children learned to talk, they would develop the kind of response generalization that would 'push them over' into normalcy'' (p. 16). In addition, the research literature on emergent verbal behavior skills often uses the term response generalization in an explanatory capacity (e.g., Goldsmith, LeBlanc & Sautter, 2007; Noell, Connell, & Duhon, 2006; Wesolowski, Zencius, McCarthy-Lydon & Lydon, 2005). As another example, Sundberg (2008a) describes the failure to show response generalization as a critical barrier to children's progress in language:

> The second type of generalization is response generalization. Here, a child may learn one response under the control of one stimulus (e.g., saying ''cat'' when asked to name an animal), but fail to provide any other responses that would be considered appropriate under that same stimulus (e.g., the response ''rabbit'' would also be considered a correct response to the question). The failure to demonstrate response generalization is often part of what is often identified as ''rote verbal responding.'' A child always gives the same answer to questions, despite the fact that there could be many variations to what would be considered a correct answer.'' (p. 118)

The importance of novel or untrained responding as a critical progress marker is also acknowledged within widely employed assessment tools such as the *Verbal Behavior: Milestones Assessment and Placement Program* (VB-MAPP; Sundberg, 2008b) and the *Assessment of Basic Language and Learning Skills* (ABLLS; Partington & Sundberg, 1998). In these assessments also, such responding is explicitly referred to as response generalization. Consider the following items for example:

> Shows response generalization for 5 items (i.e., tacts the same stimulus with two different words *teacher* and *Katie*; *cat* and *Garfield*; *dog* and *Maggie*). (Sundberg, 2008b, p. 46)

> Shows response generalization by describing the same 10 objects, events, pets, people, etc. in 3 different ways (e.g., in reference to a pet dog Toby, the child says at different times *a dog*, *an animal*, *Toby*). (Sundberg, 2008b, p. 67)

> Generalized response forms: The student will be able to use other appropriate responses after learning a response to a given situation…. Upon seeing a dog, the student may say ''dog'', ''puppy'', ''K-9'', ''pooch'', etc. When answering a question regarding ''things to eat'', the student may say ''apple, banana, bread'' OR ''cake, pizza, apple.'' (Partington & Sundberg, 1998, p. 62)

As with the quotations from Lovaas (2003) and Sundberg (2008a), these excerpts suggest both the importance of generativity itself as well as of the phenomenon of response generalization as the process underlying it.

Thus, response generalization seems to be recognized as a key process that underlies language generativity. The fact that this process has been recognized as such would seem to suggest that behavior analysts have an agreed understanding of the latter at a technical level, which should in turn facilitate continuing incremental progress with respect to prediction and influence in the applied domain. However, as has been pointed out, progress with respect to language generativity seems to have been extremely limited. Why might this be the case? To look for a possible answer, let's consider the concept of response generalization. How exactly is response generalization defined? In fact, as we will see, there has been a lack of agreement on a definition and none of the core definitions seem consistent with the phenomenon to be explained.

Definitions of Response Generalization

Kazdin (1994) cites Skinner's (1953) conceptualization of response generalization as a process in which ''reinforcement of a response increases the probability of other responses that are similar [to that response]'' (p. 54). After providing this definition, Kazdin explicitly highlights the importance of physical similarity as the central feature of this phenomenon. Furthermore, he suggests that use of the term *response generalization* to explain the emergence of nontargeted responses that are not physically similar to a previously trained response is typically incorrect.

More recently, Mayer, Sulzer-Azaroff, and Wallace (2011) have provided the following definition of response generalization:

> The spread of effects to other classes of behavior when one class of behavior is modified by reinforcement, extinction and so on. The shift in the form or topography of a behavior. For instance, the way a particular letter is shaped or formed may vary in ways that are similar but not identical to the formation of the letter as it was originally reinforced. (p. 698)

Thus, in both these cases, response generalization is defined as involving physically similar responses. Given this definition, however, many if not most examples of language generativity that response generalization is being used to explain cannot be examples of the latter because there is no obvious physical similarity between the novel response and any previously reinforced responses.

For instance, in the example of language generativity in Sundberg and Partington (1998) provided above, a student was said to produce a variety of topographically different responses upon seeing a dog including ''dog,'' ''puppy,'' ''K-9,'' ''pooch,'' etc. The idea is that the child was taught to name a stimulus and then produced one or more novel names for that same stimulus that were physically dissimilar to the one formally taught. However, such a pattern cannot be accounted for as response generalization if physical similarity between trained and untrained emergent responses is an essential prerequisite. Of course the authors of Sundberg and Partington (1998) might argue that their use of the term *response generalization* in this context does not refer to a process that relies on physical similarity but as such this use would not cohere with the definitions just provided, which suggests a lack of intradiscipline consistency in this regard, an idea upon which we will shall expand.

Many other approaches to the concept of response generalization also at least imply the importance of physical similarity. Catania (2006), for example, equates response generalization with induction, which he defines as ''the spread of the effects of reinforcement to responses outside the limits of an operant class'' (p. 393) and he provides an example of this latter process in which the spread of effects is obviously based on physical similarity. Austin and Wilson (2002) suggest that response generalization happens ''when reinforced responses co-vary with similar but unreinforced responses'' (p. 42) and they cite Catania's example to support the contention that the process is based on physical similarity.

Despite the fact that many accounts of response generalization suggest physical similarity as a core aspect of it, not all accounts do, as just hinted at in respect of the usage by Sundberg and Partington (1998). For example, some include physical similarity as a possible process but also explicitly suggest other possibilities. In Martin and Pear (2011), for example, response generalization is defined as a phenomenon that ''occurs when a behavior becomes more probable as the result of reinforcement of another behavior'' (p. 193). They then go on to suggest that ''response generalization occurs for several reasons'' including ''unlearned response generalization due to considerable physical similarity,… learned response generalization based on minimal physical similarity… [and] learned response generalization due to functionally equivalent responses'' (p. 193). In the case of the latter two categories, some examples given are, respectively, use of the letter ''s'' to tact plurality in novel cases after being taught to do it in one or more particular cases, and being able to start a campfire in a variety of different ways, having learned functionally equivalent responses. In the case of the first of these, this is arguably an example of recombinative generalization, (e.g., Suchowierska, 2006) and is discussed in Martin and Pear as an example of the result of training sufficient response exemplars. With respect to the latter, Carr (1988) has also argued for functional equivalence as a possible process underlying response generalization.

By including these latter processes under the umbrella term response generalization, these authors are taking a different stance on the conceptualization of this phenomenon than some of the previous ones. One way in which they are doing so is by including a variety of different processes in their conceptualization. It might be argued that they are diluting the meaning of this term by doing so. A possible counterargument is that it is appropriate to define a term such as this so as to include a relatively broad range of phenomena. Nevertheless, in either event, this suggests that there is some disagreement with respect to the conceptualization of response generalization. Even if it is agreed that the latter need not always be based on physical similarity alone, the fact that there is disagreement with respect to the meaning of the term is problematic, because when it is used as an explanation for examples of generativity, it is unclear which basic behavioral phenomenon might be at issue.

A similar criticism also applies if response generalization is being used as an umbrella term, as in Martin and Pear (2011), because even if it was universally agreed that the term should be used in this way, ultimately, if sufficient precision was required, it would still be necessary to specify which particular process was relevant in any particular context. In this case, perhaps we might concede that the use of the term might be appropriate so long as it was subsequently specified which subcategory of response generalization was at issue. However, even granting that this might be the case, the processes additional to generalization based on physical similarity that Martin and Pear actually suggest do not seem adequate to explaining language generativity. As indicated previously, these additional categories are explicitly described as being ''learned'' and thus this explanation would seem to have limited scope as regards the explanation of generativity, which concerns *untaught* novel behavior.

Cooper, Heron, and Heward (2007) provide a definition of response generalization that is similar in certain respects to that provided by Martin and Pear (2011). According to this definition ''[r]esponse generalization is the extent to which a learner emits untrained responses that are functionally equivalent to the trained target behavior'' (p. 620). They also provide a number of examples. Their definition is similar to that provided by Martin and Pear (2011) in that it includes, but is not limited to, examples based on physical similarity. A number of the examples that they subsequently give seem to be based on physical similarity, but one is quite obviously not based on it. The latter, which involves alternative and physically dissimilar ways of taking phone messages, is similar to the campfire example given by Martin and Pear. Thus, ultimately, as regards the explanation of generativity, the same comments as made with respect to the Martin and Pear conceptualization of response generalization apply.

Language Generativity and Response Generalization

Language generativity has proven a major challenge because for a long time behavior analysis has not had an adequate theoretical explanation of this phenomenon (cf., Malott, 2003). Furthermore, we would argue that the use of the term response generalization in relation to this phenomenon has not been helpful in this respect. Though this term seems to promise a technical understanding of the phenomenon at issue, an examination of definitions and approaches to response generalization that appear in the literature suggests that it does not do so. Instead, the use of this term to cover a wide variety of emergent language behavior has obscured the potential processes involved, and has not helped lead to the development of procedures for actually programming for generativity.

In fact, we are not the first to offer a critique of the use of the term response generalization. For example, in discussing its use as an explanation of novel behavior more generally, Alessi (1987) suggested, ''the term seems to denote a kind of magical process, used as an explanatory fiction. Novel responses are said to be products of 'generalization' from previous learning, with little regard for the complexity of the responses emitted, and without elaboration of the behavioral principles that might underlay such a process'' (p. 16). Similarly, Drabman, Hammer, and Rosenblaum (1979) state, ''[t]he omnifarious nature of this definition underscores the need for more descriptive labeling or categorization of generalized effects, so that researchers may communicate more clearly, and more discrete analyses of the important parameters involved may be performed. The current practice of subjective reference to a variety of phenomena as generalization is unacceptable if a technology for programming these effects is to be developed'' (p. 204).

In summary, then, though the term response generalization seems to promise a technical understanding of the phenomenon of language generativity at a process level, the above investigation of definitions and approaches to this term that appear in the literature suggests that it does not do so. This indicates that behavior analytic science and practice might look further afield for an understanding of this critically important phenomenon. We argue that for both theoretical and empirical reasons, a more promising candidate for the role of key process underlying language generativity is derived relational responding. In what follows, we briefly introduce this concept and discuss some studies that show its relevance to language generativity.

DERIVED RELATIONAL RESPONDING

Sidman (1971) reported one of the first empirical demonstrations of derived equivalence responding. In the study in question, Sidman was attempting to use conditional discrimination training to teach a developmentally delayed individual to read. This participant was already able to select particular pictures (A) in the presence of corresponding spoken words (B) and to tact the pictures, that is, to produce the appropriate spoken words (B) in the presence of the pictures (A). He was then taught to select appropriate textual stimuli (C) in the presence of the corresponding spoken words (B). The participant subsequently showed several derived or untaught performances including (a) producing the appropriate spoken words (B) in the presence of the textual stimuli (C), which was a reversal of the taught performance that Sidman came to refer to as symmetrical responding or symmetry; and (b) choosing the appropriate textual stimuli in the presence of pictures and vice versa (i.e., C→A and A→C), which was based on a combination of more than one of the previously established relations and which Sidman came to refer to as transitive responding or transitivity. As Sidman noted, the overarching pattern that was observed seemed to be one in which the participants were responding to particular stimuli (i.e., a spoken word, together with a picture and textual stimulus) as being ''equivalent'' to each other and hence this pattern of derived relational responding came to be known as *stimulus equivalence*.

Equivalence Research

Stimulus equivalence has been the subject of a great deal of basic and applied research involving both typically developing and developmentally delayed individuals (Rehfeldt, 2011; Rehfeldt & Barnes-Holmes, 2009; Sidman, 1994). There are both theoretical and practical reasons for the level of research interest. From a theoretical perspective, it is interesting because it is not readily predicted based on conventional behavior analytic principles (Barnes, 1994; Sidman, 2000). In addition, it appears to be linked with human language. For example, research has shown that only individuals with a minimal verbal repertoire tend to pass conventional tests of stimulus equivalence (e.g., Devaney, Hayes, & Nelson, 1986). Furthermore, many of its key features resemble features of language; for instance, the interchangeability of stimuli in an equivalence relation resembles the symbolic property of language. From a practical perspective, stimulus equivalence is a tremendously efficient method of training and as such has great educational potential; for example, Sidman (1971) reported that training 20 conditional discriminative performances allowed the subsequent demonstration of approximately 40 additional derived performances. Also relevant in this respect is the related phenomenon of transfer of function whereby a psychological function inhering in one member of a group of equivalent stimuli transfers to other members of the group. This phenomenon has been demonstrated in numerous research studies. For instance in Barnes, Browne, Smeets and Roche (1995), children were first trained and tested for three-member equivalence relations (A1-B1-C1, A2-B2-C2). They were then trained to perform specific actions in the presence of particular stimuli involved in those equivalence relations (e.g., clapping in the presence of C1 and waving in the presence of C2) and subsequently showed those actions in the presence of stimuli in derived relations with the original ones (i.e., clapping in the presence of A1 and waving in the presence of A2). This empirically demonstrated phenomenon, which, as regards theoretical interest, has been suggested to model the process of linguistic control, is tremendously efficient as regards the training of novel repertoires and thus, is of particular practical benefit.

One core feature of stimulus equivalence intimately related to each of these points is its generativity (e.g., Wulfert & Hayes, 1988). Though all successful demonstrations of stimulus equivalence constitute evidence of the generative nature of this phenomenon, a particular few have emphasized this property. Wulfert and Hayes (1988), for example, provided a noteworthy demonstration in this respect. Eight adult participants were first trained and tested for the formation of two 4-member equivalence relations (A1-B1-C1-D1, A2-B2-C2-D2). They were then taught to arrange one comparison stimulus from each relation in a particular order (e.g., B1→B2), after which they spontaneously ordered all other members of the relations the same way (e.g., C1→C2) thus demonstrating the transfer of an ''ordering'' function. Next the ordering response was brought under conditional control (i.e., in Context 1 the correct order was B1→B2, while in Context 2, it was B2→B1) and this conditional sequencing also transferred via the equivalence relations (e.g., in Context 1, they responded C1→C2, while in Context 2 they responded C2→C1). Finally, the originally trained conditional discriminations were also brought under higher order conditional control (e.g., whereas in Context X they had to choose B1 with A1 and B2 with A2, in Context Y they had to choose B2 with A1 and B1 with A2) and this resulted in four conditional equivalence classes (Context X: A1-B1-C1-D1, A2-B2-C2-D2; Context Y: A1-B2-C1-D1, A2-B1-C2-D2). Thus, the end result of this protocol was that for all 8 adult participants, 120 derived sequences emerged from eight trained sequences. From a theoretical perspective, this was an early demonstration of how transfer of function through equivalence relations might model relatively complex features of language such as syntax and generative grammar, while from a practical perspective, it constitutes a powerful example of the efficiency of the phenomenon of derived equivalence relations in terms of the establishing of novel responding.

Further Derived Relations

Stimulus equivalence, including the accompanying transfer of function effect, is the most well-known and well-researched example of derived relational responding and as we have just seen, it is both linked with language and is also highly generative. However, stimulus equivalence is not the only form of derived relations for which there is empirical evidence. Researchers have demonstrated several other forms of derived relations in human participants also including, for example, distinction (e.g., Steele & Hayes, 1991), opposition (e.g., Dymond, Roche, Whelan, Forsyth & Rhoden, 2007), comparison (Dougher, Hamilton, Fink & Harrington, 2007), deixis (McHugh, Barnes-Holmes, Barnes-Holmes & Stewart, 2006), temporality (O'Hora, Barnes-Holmes, Roche & Smeets, 2004), and analogy (e.g., Stewart, Barnes-Holmes, Roche & Smeets, 2004).

Furthermore, there is evidence that these additional patterns of derived responding are at least as generative as equivalence and are also relevant to language. With respect to generativity, for instance, nonequivalence relations have been shown to produce not simply transfer of function, whereby stimuli acquire similar functions to others to which they are related, as happens in equivalence, but transformation of function, whereby they acquire novel functions in accordance with the derived relation produced. For example, in Dougher et al. (2007), participants derived a comparative relation between two stimuli, B and C, and subsequently showed higher levels of physiological arousal to the latter than to the former even though only the latter had been explicitly conditioned. This is just one of many empirical examples of the transformation of functions, and these phenomena constitute yet further demonstration of the generative nature of derived relations. With respect to the relevance of nonequivalence relations to language, there are also multiple relevant empirical demonstrations. For instance, Whelan, Cullinan, O'Donovan, and Rodríguez Valverde (2005) showed mediated priming effects in the context of derived same and opposite relations, whereas O'Hora, Pelaez, and Barnes-Holmes (2005) have shown that derived before-after relational responding correlates with verbal IQ.

Explanations of Derived Relational Responding

The weight of empirical evidence thus far provided supports the link between derived relations and generative language and suggests that the former can provide some useful insight into understanding the latter. However, this brings us to a core theoretical question: What exactly is derived relational responding and how do humans learn to do it? There are a number of relatively recent behavior-analytic accounts that are relevant with respect to providing answers. These accounts include relational frame theory (RFT; e.g., Dymond & Roche, in press; Hayes, Barnes-Holmes & Roche, 2001), naming (e.g., Horne & Lowe, 1996), and joint control (e.g., Lowenkron, 1998, 2004).

In the case of RFT derived relational responding is explained as generalized contextually controlled patterns of responding (see Barnes, 1994; Stewart & McElwee, 2009) that are based on a history of multiple exemplar training (MET) in which the functions of the contextual cues controlling the patterns involved are established. In the case of the naming and joint control accounts, MET is invoked as a means of establishing not derived relational responding itself but instead a covert mediational process (i.e., ''naming'' and ''joint control'' respectively) that is argued to give rise to derived relational responding.

From a philosophy of science point of view, the fact that both naming and joint control require an additional mediational process to explain derived relations in comparison with RFT can be seen as a weakness of the former vis a vis the latter, because the additional process makes these accounts less parsimonious than RFT, at least in this respect. In addition, the RFT approach has at least one other advantage over naming and joint control. Whereas the two alternatives have provided relatively little discussion of or research into types of derived relations other than equivalence (for which there is now substantive empirical evidence; see, for example, Dymond & Roche, in press), RFT has provided extensive discussion of nonequivalence relations, and in addition, has contributed a considerable amount of empirical research on a variety of these relations including those cited previously in the current article. For these reasons, we support an RFT account of derived relations. In what follows we will spend some time describing this account in more detail, including some recent studies conducted by RFT researchers that seem particularly relevant to generative language.

RELATIONAL FRAME THEORY

Having provided an explanation of why we favor the RFT account of the nature and origins of derived relational responding over others, we will now provide a more detailed description of this account. We start by considering the RFT explanation of one of the earliest and arguably most fundamental types of derived relational responding, namely, *bidirectional word-object relations*.

Origins of Derived Word-Object Relations

Word-object bidirectional relations, which even very young typically developing children demonstrate, illustrate a very simple, yet common type of derived relational responding. An example is as follows. I teach a child to emit the word ''astrolabe'' in the presence of an object that she has never seen before (taught: object-word relation). Later on, in the vicinity of that same object, I ask her to point out the astrolabe and she does it quickly and easily without any training (derived word-object relation). It can work the other way round as well. I might first teach the word-object relation by reinforcing selection of the appropriate object from an array after I say the word ''astrolabe.'' Later I present the astrolabe and ask her what it is and she answers correctly.

RFT explains this ability to derive the untaught relation between a word and an object after being trained in the other direction as responding in accordance with a derived coordination (''sameness'') relation between the word and the object. This is the earliest form of derived relational responding to be established. We learn this pattern through exposure to certain contingencies of reinforcement provided at a very early age. For example, caregivers will often utter the name of an object in the presence of an infant and then reinforce any orienting response that occurs toward the particular object (''hear name A→look at object B''). They will also often present an object to the infant and then model and reinforce an appropriate naming response (''see object B→hear and say name A''). In this way, the caregiver effectively teaches the child in both directions in the bidirectional relational pattern. Furthermore, this informal training consistently occurs in the presence of particular contextual cues such as the word ''is,'' the phrase ''name of,'' or the presence of both a novel object and novel name. RFT suggests that after a sufficient number of name-to-object and object-to-name exemplars have been taught, these contextual cues become discriminative for the bidirectional pattern and the generalized operant response class of what we might refer to as derived ''naming'' (i.e., treating an object and a word as the same as each other) is thereby established. Imagine, for instance, that a child with this multiple exemplar history is told, ''This is your ball.'' Contextual cues, such as those listed, will now be discriminative for symmetrical responding between the name and the object. Thus, without any additional training, the child will now point to the ball when asked, ''Where is the ball?'' (Name A→Object B) and will answer ''ball'' when presented with the ball and asked ''What is this?'' (Object B→Name A).

Origins of Derived Equivalence

In RFT, derived naming is seen as a generalized or overarching response class generated by a history of reinforcement across multiple exemplars. Once the generalized pattern has been acquired, the child has the repertoire to derive an untaught symmetrical relation from a trained relation, no matter what the physical features of the word-object pair involved. RFT also argues that the emergence of naming as a contextually controlled generalized response class is an important precursor to the emergence of stimulus equivalence. Naming is an example of symmetrical responding, which is a key element in stimulus equivalence. However, of course, stimulus equivalence requires not just derived symmetry but also derived transitivity. The child will learn to respond in accordance with a generalized transitive relational pattern through multiple exemplars in which responding in accordance with this pattern is reinforced, just as happens with naming. Cues such as ''goes with,'' for instance, might come to control such performances. For example, the child may learn with multiple sets of objects that if X (e.g., spoken word ''dog'') ''goes with'' Y (e.g., picture of dog) and Y ''goes with'' Z (e.g., written word ''dog'') then X (spoken word) ''goes with'' Z (picture) and vice versa.

In addition, the matching-to-sample format, which is used to probe for stimulus equivalence, likely becomes a contextual cue for ''sameness'' relational responding early on, because this format is one that is employed in many early educational contexts. Consider how often children are required to look at a word or a picture and then to choose the appropriate corresponding correct word or picture from an array. This training, which will happen in both formal and informal settings, means that the matching-to-sample format becomes a contextual cue for sameness responding. Cues for generalized sameness then come to control the generalized pattern such that in the presence of the cue, whether that cue is a particular word or phrase (e.g., ''name,'' ''same as'' or ''goes with'') or physical format (e.g., matching-to-sample), being explicitly taught one element of the pattern allows the derivation of other elements in the absence of training. This is what RFT suggests happens with the phenomenon of stimulus equivalence. In a typical demonstration of stimulus equivalence, an individual might be taught to choose B1 with A1 and B2 with A2, and also to choose C1 with B1 and C2 with B2. Traditional analysis would suggest that these four unidirectional relational performances are the sum total of what has been learned but because these performances are trained using a particular format (e.g., a ''matching to sample'' format) the operant of generalized sameness relational responding is brought to bear on the stimuli so that A1, B1, and C1 are now treated as the same as each other and so too are A2, B2, and C2 and hence, if the appropriate tests are provided, then several apparently untrained or derived performances (e.g., symmetry (selecting A1 with B1, A2 with B2, B1 with C1, B2 with C2) and transitivity (selecting A1 with C1 and vice versa) will likely be demonstrated. Hence, acquiring a repertoire of generalized derived relational responding is potentially extremely generative.

Further Derived Relations

Thus, RFT researchers consider the derived relations of naming and stimulus equivalence as forms of generalized contextually controlled relational responding. As has been detailed, these are both examples of relational responding in accordance with sameness or coordination; however, as discussed earlier, this is just one form of derived relations. There are many other patterns of derived relations, and RFT researchers have provided increasing empirical support for the existence of these response patterns (e.g., Barnes-Holmes, Barnes-Holmes, Smeets, Strand, & Friman, 2004; Barnes-Holmes, Barnes-Holmes, & Smeets, 2004; Berens & Hayes, 2007; Carpentier, Smeets, & Barnes-Holmes, 2003; Roche & Barnes, 1997; see also Dymond, May, Munnelly, & Hoon, 2010; Rehfeldt & Barnes-Holmes, 2009).

Berens and Hayes (2007) provided an illustration of an RFT training protocol to establish a form of noncoordinate derived relational responding in a number of typically developing children. More specifically, they assessed and trained arbitrary comparative (more-less) relations in a group of four children aged approximately 4–5 years. They used a task involving same-size colored stimuli (referred to as colored coins) in which the children were given contextual cues of ''more'' or ''less'' to establish arbitrary relations between the stimuli and then tested to see whether they could derive the appropriate comparative relations. Using a combined multiple-baseline and multiple-probe design, the researchers showed that reinforced multiple-exemplar training could facilitate the development of arbitrary comparative relations, and that these skills generalized across both stimuli and trial types. In addition, a key element of remediation was the use of nonarbitrary training. Nonarbitrary relations are seen by RFT as an important precursor to the normal development of many forms of derived relational responding. With regard to derived comparative relations, for example, it is argued that children first learn to respond in accordance with nonarbitrary or physical relations of more than and less than (e.g., learning to pick the physically bigger quantity when asked which is more, and the physically smaller when asked which is less) before learning to respond in accordance with the abstract or generalized pattern of derived comparison (e.g., learning that if coin A is more than coin B then coin B is always worth less than coin A, no matter what size they are). Berens and Hayes incorporated nonarbitrary training into their protocol by teaching children to respond appropriately to physically different quantities of coins under the control of the contextual cues ''more'' and ''less'' before subsequently testing them for appropriate derived relational responding with the arbitrary colored stimuli.

Despite the diversity of forms of derived relations, three defining generative features characterize them all: (a) mutual entailment, (b) combinatorial entailment, and (c) transformation of function. *Mutual entailment* describes the feature of derived relational responding wherein if a stimulus A is related to another stimulus B in a certain context, then a novel relation between B and A may be derived in that context. For instance, in the context of a game using arbitrary colored circles as coins, such as that used by Berens and Hayes (2007), if I tell a child that coin A is more than coin B, I can test for mutual entailment by then asking which coin is less. *Combinatorial entailment* occurs when at least two stimulus relations combine to allow the derivation of a novel relation. For example, if I tell a child that coin A is worth more than coin B and coin B is worth more than coin C, I can test for combinatorial entailment by asking which of the two coins A or C is more (or less). *Transformation of stimulus functions* is the phenomenon whereby, if stimuli A and B participate in a relation, and A has acquired some psychological function, then in a context that selects particular stimulus functions of A as behaviorally relevant, the stimulus functions of B will be transformed in accordance with that relation. For instance, after asking the child in the example which coin they would prefer (i.e., an appetitive function), if they select the coin that is ''more,'' this is evidence of transformation of function.

Much of the initial work by RFT researchers focused on demonstrating derived relational responding in typically developing adults and children. For example, Barnes-Holmes, Barnes-Holmes, Smeets, Strand, and Friman (2004) and Barnes-Holmes, Barnes-Holmes, and Smeets (2004) trained repertoires of more than-less than and opposite derived relations, respectively, in young typically developing children aged between 4 and 6 years, when they were found to be absent. This work with typically developing individuals is important for a number of reasons, including the empirical demonstration and examination of the theoretical phenomena at issue. It has also prepared the ground for research involving the training and remediation of derived relational responding in populations in whom it is seen to be deficient. Indeed, recently there has been an increasing amount of derived relations-based work with individuals with developmental disorders involving language delay.

DERIVED MANDING

There have now been a number of studies that have focused on derived relational responding in children with developmental delay (e.g., Greer, 2008; Moran, Stewart, McElwee, & Ming, 2010; Rehfeldt, Dillen, Ziomek, & Kowalchuk, 2007; Murphy, Barnes-Holmes, & Barnes-Holmes, 2005). We will consider one series of studies in particular, as it provides a good illustration of progressive research in this domain as well as an illustration of the generative potential of this work. The series of studies in question is a work that has focused on derived or emergent ''manding.''

Initial Studies

Rehfeldt and Root (2005) provided the first example of the transfer of derived manding. In their study, they first taught three adults with developmental disabilities to request preferred items (e.g., candy) using pictures. They then trained conditional discriminative selection of pictures of items in the presence of their dictated names (i.e., A→B) and printed item names in the presence of their dictated names (i.e., A→C). They then tested for transfer of function from the B to the C stimuli via derived equivalence by examining whether participants would request preferred items using text stimuli. All 3 participants demonstrated this completely novel untaught outcome. Halvey and Rehfeldt (2005) extended this paradigm by showing a similar transfer in the case of vocal mand requests using category names for three adults with developmental disabilities.

Rosales and Rehfeldt (2007) also extended this work by showing transfer in the context of contrived transitive conditioned establishing operations for two developmentally disabled adults. Participants were first trained to mand for items needed to complete chained tasks. For example, one task required that participants listen to a CD on a CD player and thus they learned a series (chain) of steps involving a CD, a CD player, and a set of headphones. When they reached the point in the chain at which the headphones were needed, they were required to mand for them by handing over a picture of them. After conditional discrimination training, they exchanged text representations that were in equivalence relations with the original items, thus showing derived manding in the context of contrived conditioned establishing operations.

Murphy et al. (2005) also showed derived manding with contrived conditioned establishing operations but in the context of a symbol game and involving children with autism as participants. In addition, this was the first study to incorporate multiple exemplar training in order to train the transfer of function effect when it did not emerge initially. The three children were first trained to hand over one of two different symbol-cards, A1 or A2, in order to gain one of two different token cards, X1 or X2, respectively, in order to complete a game board and receive reinforcement. This training resulted in the cards A1 and A2 acquiring specific discriminative functions in the context of the game, which the authors referred to as ''manding'' functions, because the children could use the respective cards to mand for particular token cards in that context. The authors then trained two three-member equivalence relations (A1-B1-C1 and A2-B2-C2) and probed for the untrained transfer of manding functions to appropriate C stimulus cards; in other words, they tested to see whether children would subsequently hand over a card with C1 for an X1 token and a card with C2 for an X2 token. Two of the children did so immediately, but a third did so after multiple exemplar training in which the transfer of function was explicitly trained across multiple novel stimulus sets. After this initial section of the study, participants were trained in a further set of two three-member equivalence relations (X1-Y1-Z1, X2-Y2-Z2) and all three showed immediate transfer of reinforcing functions such that, without further training, they worked to acquire Z1 and Z2 rather than X1 and X2. Finally, they were also tested for and demonstrated derived manding (i.e., with C1 and C2) for derived reinforcers (i.e., Z1 and Z2).

Derived Comparative Manding

In Murphy and Barnes-Holmes (2009), the basic paradigm shown in Murphy et al. (2005) was extended to comparative manding. Three children with autism were trained to mand for an increase in quantity of tokens using stimulus A1 and to mand for a decrease using stimulus A2, thus establishing A1 and A2 as having comparative mand functions. They were then given conditional discrimination training so as to establish two three-member equivalence relations (A1-B1-C1 and A2-B2-C2) and they subsequently showed transfer of the comparative mand functions via equivalence when, in the absence of further training, they used C1 to mand for an increase and C2 to mand for a decrease. In addition, when the researchers reversed the B–C conditional discriminations, participants showed derived reversed more–less mands (mand with C1 for less, C2 for more) and when they reversed the conditional discriminations once again, they showed the original derivations.

In Murphy and Barnes-Holmes (2010a) the paradigm was further extended. Three 14-year-old participants diagnosed with autism spectrum disorder (ASD) were trained in a more precise form of comparative manding than that seen in Murphy and Barnes-Holmes (2009) in which they learned to use five different A stimuli to mand for either −2, −1, zero, +1, or +2 tokens. They were then given training and testing sufficient to establish five three-member equivalence relations (i.e., A1-B1-C1, A2-B2-C2, A3-B3-C3, A4-B4-C4, A5-B5-C5) and subsequently all but one immediately showed transfer of the comparative functions from the A stimuli via equivalence relations to the C stimuli. The remaining participant showed the derived performance after receiving multiple exemplar training.

Derived Manding Via Nonequivalence Relations

Finally, Murphy and Barnes-Holmes (2010b) demonstrated the most complex example of transformation of functions thus far shown with individuals with ASD and this study also demonstrated derived manding with nonequivalence relations. In this study, 4 14-year-old participants with ASD were first trained to use five different arbitrary stimuli to mand for either −2, −1, zero, +1, or +2 tokens. They were then given training to establish two arbitrary stimuli X and Y as contextual cues for more and less respectively and then these cues were used to establish generalized comparative relations among five arbitrary stimuli (A > B > C > D > E). After the C stimulus from the latter group was given a function of manding for zero tokens, all children but one immediately showed appropriate transformation of the functions of the remaining stimuli. In the case of the remaining individual, he showed the appropriate performance after receiving multiple exemplar training for comparative relations. In addition, in the case of 1 of the 4 participants (a) training and testing was given such that the comparative relations among the arbitrary stimuli were altered (i.e., C > A > D > E > B) and the transformation of functions was seen to change accordingly, and (b) training and testing was given to restore the original comparative relations and the original pattern of transformation of functions was also restored.

The studies reviewed here provide a good illustration of the generativity of the phenomena of derived relational responding and transfer or transformation of function and how these phenomena are relevant to the rapid production of potentially useful new patterns of responding. In addition, they offer empirical evidence not only of the generative effects themselves but also how the procedure of multiple exemplar training can be used to increase the likelihood of obtaining those effects.

RFT AND GENERATIVITY

We have argued that derived relational responding, which is suggested by RFT to be a type of generalized contextually controlled operant, is the key to understanding generative language. The series of studies just reviewed provides a good illustration of recent basic research on derived relations with developmentally delayed individuals, both adults and children, and suggests the theoretical and applied potential of this work, particularly with respect to explaining and developing generativity. Having thus introduced and explained derived relational responding and provided some general idea of the potential of this approach, at this point, we will reconsider some of the phenomena discussed in the initial part of this paper and explain how they might be considered in light of this approach.

The phenomena discussed earlier as examples of response generalization included the following examples from popular verbal behavior assessment tools:

> Shows response generalization for 5 items (i.e., tacts the same stimulus with two different words *teacher* and *Katie*; *cat* and *Garfield*; *dog* and *Maggie*). (Sundberg, 2008b, p. 46)

> Shows response generalization by describing the same 10 objects, events, pets, people, etc. in 3 different ways (e.g., in reference to a pet dog Toby, the child says at different times *a dog*, *an animal*, *Toby*). (Sundberg, 2008b, p. 67)

> Generalized response forms: The student will be able to use other appropriate responses after learning a response to a given situation…. Upon seeing a dog, the student may say ''dog'', ''puppy'', ''K-9'', ''pooch'', etc. When answering a question regarding ''things to eat'', the student may say ''apple, banana, bread'' OR ''cake, pizza, apple. (Partington & Sundberg, 1998, p. 62)

As suggested earlier, though these phenomena were labeled response generalization, no interpretation of the latter as technical process seems to be able to account for how these performances might have come about, so ultimately this labeling does not seem useful. On the other hand, the concept of derived relational responding can be used to explain these phenomena and, more importantly, it can be used to suggest what type of training might be provided so as to allow children not yet showing such performances to do so. In the case of each of the three examples here, these might be interpreted as examples of derived equivalence responding. In the first case, for instance, if a child had previously learned to tact a particular individual (stimulus A) as ''teacher'' (stimulus B), and had also been told on another occasion that ''the teacher's name is Katie'' (stimulus C), then, assuming she has a repertoire of derived equivalence responding, she might subsequently begin to treat A, B, and C as equivalent and thus be able to show several untaught performances, such as tacting the individual as Katie (derived A→C responding), or pointing to the individual when asked where Katie is (derived C→A responding). The other examples might be similarly interpreted. Assuming the child has an equivalence repertoire, in each case he or she would only need to be taught some of the performances before being able to derive additional untaught relations. Of course, though stimulus equivalence is an empirically demonstrable and predictable phenomenon, and thus the concept of equivalence can be used to predict and interpret untrained performances in particular circumstances, it also needs to be explained. The RFT-based account being offered here explains it as generalized coordinate relational responding and suggests that if a child has not yet acquired a repertoire of deriving relations in accordance with equivalence then it may be possible to train him or her to do so by using multiple exemplar training.

This theoretical approach can also be used to provide additional insight. In the third case, though a child with an equivalence repertoire alone might respond appropriately to the question regarding ‘‘things to eat’’ based on the derivation of an equivalence relation between the phrase ‘‘things to eat’’ and each of the individual items, it would seem that such a question is probing for a more advanced form of responding. In this case, a fully appropriate repertoire of responding to questions of this type would require that the child responds to ‘‘things to eat’’ as a category and to food items as members of that category. As such, ‘‘things to eat’’ is not in the same relationship with each of the items as the items are with each other and thus, this seems slightly more complex than a simple equivalence relation. In fact, RFT would suggest that appropriate responding requires derived hierarchical relational responding (see, e.g., Hayes, Gifford, Townsend, & Barnes-Holmes, 2001), which is a more complex form of derived relations than equivalence in which relational responding is under the control of cues such as ‘‘category’’ and ‘‘type of.’’ The same type of analysis applies to an earlier example quoted from Sundberg (2008a):

> The second type of generalization is response generalization. Here, a child may learn one response under the control of one stimulus (e.g., saying ‘‘cat’’ when asked to name an animal), but fail to provide any other responses that would be considered appropriate under that same stimulus (e.g., the response ‘‘rabbit’’ would also be considered a correct response to the question). The failure to demonstrate response generalization is often part of what is often identified as ‘‘rote verbal responding.’’ A child always gives the same answer to questions, despite the fact that there could be many variations to what would be considered a correct answer. (p. 118)

In both of these cases in which derived hierarchical relations are likely implicated, a child might be tested for appropriate responding to cues for hierarchical relations and if the required responding is found to be absent, then multiple exemplar training using those types of cues might be employed as an intervention. Once again, the key point is that the processes are specifiable and assessment and intervention are possible based on this specification.

THEORETICAL ISSUES

In the current article we have argued that language generativity is explicable in terms of the phenomenon of derived relational responding, and that the latter is, in turn, best interpreted as generalized contextually controlled arbitrarily applicable relational responding or ‘‘relational framing.’’ Furthermore, we have reviewed a number of derived manding studies that constitute empirical evidence of the practical utility of derived relations and have suggested a derived relations-based explanation of a number of generative language phenomena. In this penultimate section of the article, we address a few potentially important theoretical points regarding RFT and the explanation of language generativity as derived relational responding.

What Exactly Is ‘‘Relating’’?

The core of the RFT account is that participants are ‘‘relating’’ stimuli. One question that might be asked is, what exactly is ‘‘relating’’? The answer to this is that relating is a generalized pattern of behavior performed with respect to stimuli in one’s environment that involves responding to at least one stimulus in terms of at least one other stimulus. Relating is an in-principle measurable behavior, like other commonly accepted examples of behavior such as lever-pressing, smiling, walking to the shops, and so on. For example, in the case of the relational behavior of mutual entailed sameness relations, I can assess whether, after being trained to select stimulus A in the presence of stimulus B, a participant in my experiment selects stimulus B in the presence of stimulus A, independent of the physical properties of the stimuli involved, and for a range of different stimuli. I can measure this pattern of responding just as I can assess whether a rat has pressed a lever.

One of the criticisms of the alternative accounts (i.e., naming and joint control) offered to explain the emergence of derived relational responding was that they were mediational—i.e., they relied on a covert mediational process to explain the derived relational performance. However, perhaps it might be argued that RFT is also a mediational account, because maybe relating is mediated by other behaviors? Relating could, in theory, be conceptualized as mediated by other behaviors. However, so could any other behavior. A discriminative stimulus-lever press relationship, for example, could be conceptualized as being mediated by muscular activity or electrical signals in the nervous system, just as relating on a matching to sample task could be conceptualized as being mediated by, for example, covert thinking processes. However, in such cases, the question one must ask is, ''How useful is it to conceptualize the response as being mediated?'' It is the capacity of an analysis to allow prediction and influence over the behavior of the participant that is the most important criterion in determining the variables under consideration. If relating or any other behavior can be sufficiently well-influenced without resort to mediating entities, then the latter are not a useful addition to the analysis. This is why RFT rejects a conception of relational responding as being mediated by other behaviors.

RFT as a Parsimonious Explanation for Derived Relational Responding

We have just reiterated the point that one of the advantages of RFT in comparison with a number of alternative theories offered to explain the emergence of derived relational responding is that RFT avoids the invocation of an additional mediational process. As we argued earlier, this makes RFT more parsimonious than those other approaches. However, some have argued that RFT is not a parsimonious account, insofar as RFT theorists claim that relational framing represents a novel behavioral principle. We argue that this is not the case, however.

The RFT argument that relational framing is a novel behavioral principle is based on the learning of novel behavioral functions without the need for direct training, which constitutes the transformation of functions effect. For instance, in the example used to explain transformation of functions earlier, a coin acquires an appetitive function in the absence of the direct institution of contingencies of reinforcement with respect to it and the putative appetitive function. The empirical finding that behavioral functions such as this seemingly arise through relational framing, which is itself a learned (operant) process, represents a novel behavior analytic phenomenon. Relational framing, which involves this phenomenon, has thus been argued to represent a novel behavioral principle (Hayes, Fox, Gifford, Wilson, Barnes-Holmes & Healy, 2001). This has been argued by some (e.g., Palmer, 2004) to represent a lack of parsimony on the part of RFT in relation to the issue of derived relational responding. In fact, though, there is a critical distinction to be made here. Unlike the alternative accounts referred to earlier, RFT theorists do not invoke a novel principle in order to *explain* the emergence of derived relational responding. Instead they suggest that a new behavioral principle (i.e., transformation of function through relational frames) comes about *after* a repertoire of derived relational responding has been established. Thus, RFT is not nonparsimonious in relation to explaining derived relational responding, but rather simply acknowledges already demonstrated properties of this phenomenon.

Multiple Exemplar Training as the Process Underlying Derived Relational Responding

As has been discussed in the latter stages of this article, derived relational responding is a pattern of behavior that is seen in some experimental participants whereby, after particular patterns of performance have been trained, additional untrained patterns of responding emerge. In this article, several empirical examples of this phenomenon, including derived equivalence (e.g., Rehfeldt & Root, 2005) and other kinds of derived relational responding (e.g., Murphy & Barnes-Holmes, 2010b), were described. However, it is important to distinguish the training needed to demonstrate derived relational responding in any particular instance from the multiple exemplar training (MET) that establishes the generalized ability to perform derived relational responding. Training a particular set of relations (e.g., the sound ''*Doll*'' goes with the textual stimulus ''DOLL'') is a prerequisite to the demonstration of a derived relational pattern (e.g., picking the textual stimulus ''DOLL'' in the presence of the sound ''*Doll*'') because without a set of trained relations, nothing can be derived. However, the training of the former does not by itself explain the emergence of the latter. Instead, the phenomenon of derived relations is explained by RFT as the product of a history of training of the complete set of relations involved in the derived relational pattern (e.g., both A–B and B–A), using multiple sets of physically different stimuli. Such a history eventually results in an emergent performance whereby, given a completely novel set of stimuli, only a subset of the relations need be trained, whereas the remainder can be derived. As explained, this training is referred to as MET and this is the key explanatory process that underlies the outcome of derived relational responding.

In this article, many of the empirical demonstrations described capitalized upon the fact that the participants involved in the study already demonstrated derived relational responding. For example, two of the children in Murphy et al. (2005) produced novel untrained manding responses after they were trained to mand with a particular set of stimuli and were then given limited conditional discrimination training involving those stimuli and a novel number of stimuli. Empirical demonstrations such as this are important in that they show that derived relational responding preparations, when used with children who already have the capacity to do derived relational responding, can be used to produce predictable and practically useful generative type performances. Demonstrations such as this do not show the process whereby these children came to be able to be able to do derived relational responding itself, however. Nevertheless, there are other empirical demonstrations that do show this process. In fact, an example was provided in the case of the third child in the Murphy et al. (2005) study. This child did not show a derived manding response after receiving similar training to that provided to the other children. He was therefore provided with additional training (i.e., MET) of the appropriate derived relational response pattern using a number of stimulus sets including the set on which he had failed, and eventually he showed the appropriate derived response pattern in a completely novel stimulus set. Demonstrations such as the latter are, from an RFT point of view, demonstrations of MET as the process by which the capacity to show derived relational responding is established.

Generalized Responding versus Response Generalization

One final issue that we will briefly consider is the question of whether generalized responding (including relational responding) is in fact simply a particular subtype of response generalization, which would, of course, completely undermine the argument we have been making; specifically, that response generalization is not responsible for generativity and hence we need to consider response generativity as an alternative. As has been discussed, the RFT suggestion is that multiple-exemplar training with certain patterns of relating establishes the phenomenon of generalized contextually-controlled relational responding (or relational framing). The latter phenomenon thus emerges from operant training and involves generalization of responding. Hence, it might perhaps be suggested that it is similar, or perhaps ultimately even identical, to response generalization. However, as should by now be apparent, there is at least one key difference between these phenomena. As explained in the first half of the paper, response generalization is an uncontrolled *by-product* of training contingencies. However, generalized responding is the *deliberate target* of contingencies implemented in training. In the case of generalized contextually-controlled relational responding (or relational framing), for example, contingencies are deliberately set up so as to establish control by arbitrary stimuli (which will thus become contextual cues) over a particular configuration of responding toward stimuli. This pattern of responding is expected to occur with novel stimuli in the absence of reinforcement, of course, but that is a targeted result of the training as opposed to a byproduct of it. Given the pragmatic requirement for influence over behavior that is a hallmark of behavior analysis, this is a fundamentally important difference between this phenomenon and response generalization.

SUMMARY AND CONCLUSION

We started this paper by suggesting that one widespread behavior-analytic response to the phenomenon of language generativity has been to label it response generalization. We analyzed the latter term in an attempt to pin down its meaning so as to understand how it might advance our understanding of generative language. However, an investigation of definitions and approaches to this term that appear in the literature suggested that it fails to provide a process-level explanation. We suggested that the alternative phenomenon of derived relational responding, which can be understood as a generalized contextually controlled operant, constitutes a technical approach to the type of generative phenomena that have been traditionally referred to as response generalization. We described a series of recent research studies focusing on transformation of derived manding that illustrate the potential of work focused on derived relational responding to assess and train generative behavior in the area of language delay. Based on its success to date, we believe that this type of research will continue to develop in terms of its utility and scope and will offer increasing insight into generative language with relevance for both basic and applied domains.

REFERENCES

Alessi, G. (1987). Generative strategies and teaching for generalization. *The Analysis of Verbal Behavior*, *5*, 15–27.

Austin, J., & Wilson, K. G. (2002). Response-Response relationships in organizational behavior management. *Journal of Organizational Behavior Management*, *21*(4), 39–53.

Barnes, D. (1994). Stimulus equivalence and relational frame theory. *The Psychological Record*, *44*, 91–124.

Barnes, D., Browne, M., Smeets, P., & Roche, B. (1995). A transfer of functions and a conditional transfer of functions through equivalence relations in three to six year old children. *The Psychological Record*, *45*, 405–430.

Barnes-Holmes, Y., Barnes-Holmes, D., & Smeets, P. M. (2004). Establishing relational responding in accordance with opposite as generalized operant behavior in young children. *International Journal of Psychology and Psychological Therapy*, *4*(3), 559–586.

Barnes-Holmes, Y., Barnes-Holmes, D., Smeets, P. M., Strand, P., & Friman, P. (2004). Establishing relational responding in accordance with more-than and less-than as generalized operant behavior in young children. *International Journal of Psychology and Psychological Therapy*, *4*(3), 531–558.

Berens, N. M., & Hayes, S. C. (2007). Arbitrarily applicable comparative relations: Experimental evidence for a relational operant. *Journal of Applied Behavior Analysis*, *40*(1), 45.

Carpentier, F., Smeets, P., & Barnes-Holmes, D. (2003). Equivalence-equivalence as a model of analogy: Further analyses. *Psychological Record*, *53*(3), 349–371.

Carr, E. G. (1988). Functional equivalence as a mechanism of response generalization. In R. H. Horner & R. L. Koegel (Eds.), *Generalization and maintenance: Lifestyle changes in applied settings*. Baltimore, MD: P. H. Brookes.

Catania, A. C. (2006). *Learning (Interim 4th Ed.)*. Sloan Publishing.

Cooper, J. O., Heron, T. E., & Heward, W. I. (1987). *Applied Behavior Analysis (1st Ed.)*. New York, NY: MacMillan.

Cooper, J. O., Heron, T. E., & Heward, W. I. (2007). A*pplied Behavior Analysis (2nd Ed.)*. New York, NY: MacMillan.

Devany, J. M., Hayes, S. C., & Nelson, R. O. (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior*, *46*(3), 243–257.

Drabman, R. S., Hammer, D., & Rosenbaum, M. S. (1979). Assessing generalization in behavior modification with children: The generalization map. *Behavioral Assessment*, *1*, 203–219.

Dymond, S., May, R. J., Munnelly, A., & Hoon, A. E. (2010). Evaluating the evidence base for relational frame theory: A citation analysis. *The Behavior Analyst*, *33*, 97–117.

Dymond, S., and Roche, B. (in press). *Advances in relational frame theory & contextual behavioral science: Research & application*. New York, NY: New Harbinger.

Dymond, S., Roche, B., Forsyth, J., Whelan, R., & Rhoden, J. (2007). Transformation of avoidance response functions in accordance with same and opposite relational frames. *Journal of Experimental Analysis of Behavior*, *88*(2), 249–262.

Goldsmith, T. R., LeBlanc, L. A., & Sautter, R. A. (2007). Teaching intraverbal behavior to children with autism. *Research in Autism Spectrum Disorders*, *1*(1), 1–13.

Greer, R. D. (2008). The ontogenetic selection of verbal capabilities: Contributions of Skinner's verbal behavior theory to a more comprehensive understanding of language. *International Journal of Psychology and Psychological Therapy*, *8*(3), 363–386.

Greer, R. D., & Ross, D. E. (2008). *Verbal behavior analysis: Inducing and expanding new verbal capabilities in children with language delays*. New York, NY: Allyn & Bacon.

Halvey, C., & Rehfeldt, R. A. (2005). Expanding vocal requesting repertoires via relational responding in adults with severe developmental disabilities. *The Analysis of Verbal Behavior*, *21*, 13–25.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational frame theory: A post-skinnerian account of human language and cognition*. New York, NY: Plenum Press.

Hayes, S. C., Fox, E., Gifford, E.V., Wilson, K. G., Barnes-Holmes, D., & Healy, O. (2001). Derived relational responding as learned behavior. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.) *Relational frame theory: A post-Skinnerian account of human language & cognition*. New York, NY: Plenum Press.

Hayes, S. C., Gifford, E. V., Townsend, R. C., & Barnes-Holmes, D. (2001). Thinking, problem solving and pragmatic verbal analysis. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.). *Relational frame theory: A post-skinnerian account of human language and cognition*. New York, NY: Plenum Press.

Horne, P. J., & Lowe, C. F. (1996). On the origins of naming and other symbolic behavior. *Journal of the Experimental Analysis of Behavior*, *65*(1), 185–241.

Kazdin, A. E. (1994). *Behavior modification in applied settings* (5th ed.). Pacific Grove, CA: Brooks-Cole.

Kelley, M. E., Shillingsburg, M. A., Castro, M. J., Addison, L. R., & LaRue Jr., R. H. (2007). Further evaluation of emerging speech in children with developmental disabilities: Training verbal behavior. *Journal of Applied Behavior Analysis*, *40*(3), 431–445.

Koegel, L. K., Camarata, S. M., Valdez-Menchaca, M. C., & Koegel, R. L. (1998). Teaching children with autism to use self-initiated strategy to learn expressive vocabulary. *American Journal of Mental Retardation*, *102*, 346–357.

Lord, C., & McGee, J. P. (Eds.). (2001). *Educating Children With Autism*. Committee on Educational Interventions for Children With Autism, Division of Behavioral and Social Sciences and Education, National Research Council. Washington, DC: National Academy Press.

Lovaas, O. I. (1981). *Teaching developmentally disabled children: The me book*. Baltimore, MD: University Park.

Lovaas, O. I. (1987). Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology*, *55*(1), 3–9.

Lovaas, O. I. (2003). *Teaching individuals with developmental delays: Basic intervention techniques*. Austin, TX: PRO-ED.

Lowenkron, B. (1998). Some logical functions of joint control. *Journal of the Experimental Analysis of Behavior*, *69(3)*, 327–354.

Malott, R. W. (2003). Behavior analysis and linguistic productivity. *The Analysis of Verbal Behavior*, *19*, 11–18.

Martin, G., & Pear, J. (2011). *Behavior modification: What it is and how to do it.* (9th ed.). NJ: Simon & Schuster.

Mayer, G. R., Sulzer-Azaroff, B., & Wallace, M. (2011). *Behavior analysis for lasting change*. Cornwall-on-Hudson, NY: Sloan Educational Publishing.

McEachin, J. J., Smith, T., & Lovaas, O. I. (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal of Mental Retardation*. *97*(4), 359–372.

McHugh, L., Barnes-Holmes, Y., Barnes-Holmes, D., & Stewart, I. (2006). Understanding false belief as generalized operant behaviour. *Psychological Record*, *56*(3), 341–364.

Moran, L., Stewart, I., McElwee, J., & Ming, S. (2010). Brief report: The training and assessment of relational precursors and abilities (TARPA): A preliminary analysis. *Journal of Autism and Developmental Disorders*, *40*(9), 1149–1153.

Murphy, C., & Barnes-Holmes, D. (2009). Derived more-less relational mands in children diagnosed with autism. *Journal of Applied Behavior Analysis*, *42*, 253–268.

Murphy, C., & Barnes-Holmes, D. (2010a). Establishing five derived mands in three adolescent boys with autism. *Journal of Applied Behavior Analysis*, *43*, 537–541.

Murphy, C., & Barnes-Holmes, D. (2010b). Establishing complex derived manding with children with and without a diagnosis of autism. *The Psychological Record*, *60*, 489–504.

Murphy, C., Barnes-Holmes, D., & Barnes-Holmes, Y. (2005). Derived manding in children with autism: synthesising Skinner's Verbal Behavior with relational frame theory. *Journal of Applied Behavior Analysis*, *38*, 445–462.

Noell, G. H., Connell, J. E., & Duhon, G. J. (2006). Spontaneous response generalization during whole word instruction: Reading to spell and spelling to read. *Journal of Behavioral Education*, *15*(3), 12–30.

O'Hora, D., Barnes-Holmes, D., Roche, B., & Smeets, P. (2004). Derived relational networks and control by novel instructions: A possible model of generative verbal responding. *Psychological Record 54(3)*, 437–460.

O'Hora, D., Pelaez, M., & Barnes-Holmes, D. (2005). Derived relational responding and performance on verbal subtests of the WAIS-III. *Psychological Record 55(1)*, 155–175.

Palmer, D. C. (2004). Data in search of a principle: A review of relational frame theory: A post-Skinnerian account of human language and cognition. *Journal of the Experimental Analysis of Behavior*, *81(2)*, 189–204.

Partington, J. W., & Sundberg, M. L. (1998). *The assessment of basic language and learning skills (the ABLLS): An assessment, curriculum guide, and skills tracking system for children with autism or other developmental disabilities*. Pleasant Hill, CA: Behavior Analysts.

Rehfeldt, R. A. (2011). Toward a technology of derived stimulus relations: An analysis of articles published in the journal of applied behavior analysis, 1992–2009. *Journal of Applied Behavior Analysis*, *44*(1), 109–119.

Rehfeldt, R. A., & Barnes-Holmes, Y. (2009). *Derived relational responding applications for learners with autism and other developmental disabilities: A progressive guide to change*. Oakland, CA: New Harbinger Publications.

Rehfeldt, R. A., Dillen, J. E., Ziomek, M. M., & Kowalchuk, R. K. (2007). Assessing relational learning deficits in perspective-taking in children with high functioning autism spectrum disorder. *Psychological Record*, *57*(1), 23–47.

Rehfeldt, R. A., & Root, S. L. (2005). Establishing derived requesting skills in adults with severe developmental disabilities. *Journal of Applied Behavior Analysis*, *38*, 101–105.

Remington, B., Hastings, R., Kovshoff, H., degli Espinosa, F., Jahr, E., Brown, T., Alsford, P., Lemaic, M., & Ward, N. (2007). A field effectiveness study of early intensive behavioral intervention: Outcomes for children with autism and their parents after two years. *American Journal on Mental Retardation*, *112*, 418–438.

Roche, B., & Barnes, D. (1997). A transformation of respondently conditioned stimulus function in accordance with arbitrarily applicable relations. *Journal of the Experimental Analysis of Behavior*, *67*(3), 275–301.

Rosales, R., & Rehfeldt, R. A. (2007). Contriving transitive conditioned establishing operations to establish derived manding skills in adults with severe developmental disabilities. *Journal of Applied Behavior Analysis*, *40*, 105–121.

Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research*, *14*(1), 5–13.

Sidman, M. (1994). *Equivalence relations and behavior: A research story*. Boston MA: Authors Cooperative.

Sidman, M. (2000). Equivalence relations and the reinforcement contingency. *Journal of the Experimental Analysis of Behavior*, *74*, 127–146.

Skinner, B. F. (1953). *Science and human behavior*. New York, NY: MacMillan.

Steele, D., & Hayes, S. C. (1991). Stimulus equivalence and arbitrarily applicable relational responding. *Journal of the Experimental Analysis of Behavior*, *56*(3), 519–555.

Stewart, I., Barnes-Holmes, D., Roche, B. & Smeets, P. (2004). A functional-analytic model of analogy using the relational evaluation procedure. *Psychological Record 54(4)*, 531–552.

Stewart, I., & McElwee, J. (2009). Relational responding and conditional discrimination procedures: An apparent inconsistency and clarification. *The Behavior Analyst*, *32*, 309–317.

Suchowierska, M. (2006). Recombinative generalization: Some theoretical and practical remarks. *International Journal of Psychology*, *41*(6), 514–522

Sundberg, M. L. (2008a). *VB-MAPP: Verbal behavior milestones assessment and placement program—Guide*. Concord, CA: AVB Press.

Sundberg, M. L. (2008b). *VB-MAPP: Verbal behavior milestones assessment and placement program—Protocol*. Concord, CA: AVB Press.

Sweeney-Kirwan, E. J. (2008, April). ‘‘Teaching Advanced Verbal Behavior.’’ Paper presented at a meeting of the Pennsylvania Verbal Behavior Project, Harrisburg, PA.

Wesolowski, M. D., Zencius, A. H., McCarthy-Lydon, D., & Lydon, S. (2005). Using behavioral interventions to treat speech disorders in persons with head trauma. *Behavioral Interventions*, *20*(1), 67–75.

Whelan, R., Cullinan, V., O’Donovan, A., & Rodriguez, M. (2005). Derived same and opposite relations produce association and mediated priming. *International Journal of Psychology and Psychological Therapy 5(3)*, 247–264.

Wilczynski, S. M., & Christian, L. (2008). The National Standards Project: Promoting evidence-based practice in autism spectrum disorders. In J. K. Luiselli, D. C. Russo, W. P. Christian, & S. M. Wilcyznski (Eds.), *Effective Practices for Children with Autism: Educational and Behavior Support Interventions that Work (pp.* 37–60*)*. New York, NY: Oxford University Press.

Williams, B. F., & Williams, R. L. (2010). *Effective programs for treating autism spectrum disorders: Applied behavior analysis models*. New York, NY: Routledge.

Wulfert, E., & Hayes, S. C. (1988). Transfer of a conditional ordering response through conditional equivalence classes. *Journal of the Experimental Analysis of Behavior*, *50*(2), 125–144.