TOWARD A TECHNOLOGY OF DERIVED STIMULUS RELATIONS: AN ANALYSIS OF ARTICLES PUBLISHED IN THE JOURNAL OF APPLIED BEHAVIOR ANALYSIS*, 1992–2009*

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Every article on stimulus equivalence or derived stimulus relations published in the *Journal of Applied Behavior Analysis* was evaluated in terms of characteristics that are relevant to the development of applied technologies: the type of participants, settings, procedure (automated vs. tabletop), stimuli, and stimulus sensory modality; types of relations targeted and emergent skills demonstrated by participants; and presence versus absence of evaluation of generalization and maintenance. In most respects, published reports suggested the possibility of applied technologies but left the difficult work of technology development to future investigations, suggestions for which are provided.

Key words: stimulus equivalence, derived stimulus relations, verbal behavior, generalization

Sidman (1971, 1994) popularized the use of the term *stimulus equivalence* to refer to the emergence of untaught stimulus relations following a history of reinforcement for relating the stimuli in finite ways. Sidman (1971) initially demonstrated that individuals with severe intellectual disabilities read printed words and matched printed words to pictures and pictures to printed words, a skill purportedly indicative of reading comprehension, after being instructed to match dictated names to pictures and printed words. Follow-up work showed that a vocabulary of 20 words or larger could be established through this seemingly simple conditional discrimination training paradigm (Sidman & Cresson, 1973). These findings were exciting, because they suggested not only an efficient instructional strategy that could engender a number of novel skills with minimal training investment (Stromer, Mackay, & Remington, 1996) but also the basis for a behavioral analysis of symbolic behavior and reference.

Stimuli that were shown to be equivalent to one another, whether dictated names, pictures, printed words, or any other myriad of auditory and visual stimuli, could be said to be *symbolic of,* or to *refer to* one another, a notion that had been largely dismissed by Skinner (1974), who claimed that ''meanings and referents are not to be found in words but in the circumstances under which words are used by speakers and understood by listeners'' (p. 96). Stimulus equivalence research suggested that ''meanings and referents'' reside not only in current circumstances of use but also in the relational networks into which historical experiences have placed verbal stimuli (Hayes, Barnes-Holmes, & Roche, 2001). Sidman's work thus came to be viewed by many behavior analysts as a critical tool for an emerging behavioral analysis of basic language (Stromer et al., 1996).

Sidman's (1971) early research served as the impetus for a number of applied studies that followed over the course of the next three decades, all of which held promise for the development of educational curricula based on the stimulus equivalence, or derived stimulus relations, paradigm. Incorporating such procedures into educational curricula seems to be

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beneficial not only for the expansion of receptive and expressive language skills but also for a multitude of other skills that involve responding relationally to stimuli. In fact, such an approach seems to capture a number of "best practices" in instruction articulated by Skinner (2003), including frequent opportunities for feedback, ongoing evaluation, and requiring students to master one set of skills before advancing to the next (see Critchfield & Fienup, 2008). In a well-designed educational curriculum, the learner must pass though a sequence of steps, with a series of progressive approximations to the ultimately desired complex skill (Skinner). As such, instructional protocols based on derived stimulus relations also seem to be ideal for use in conjunction with other widely used and well-reputed behavior-analytic educational curricula, including direct instruction and precision teaching (e.g., Binder, 1996; Engelmann & Carnine, 1982).

To date, however, only 27 applied studies on derived stimulus relations have been published in the discipline's flagship journal, the *Journal of Applied Behavior Analysis (JABA)*, less than one article per year since Sidman's (1971) initial pioneering efforts. Research efforts have instead focused largely on the relations between derived stimulus relations and verbal behavior and the conditions necessary and sufficient for relational repertoires to emerge. The result has been the formulation of three distinct theoretical perspectives (e.g., Hayes et al., 2001; Horne & Lowe, 1996; Sidman, 1994) and hundreds of basic laboratory studies. Much has been learned about relational learning as a behavior process, placing applied behavior analysts in an excellent position to further develop and refine the technology initiated by Sidman (1971). Although the implications of Sidman's early research for establishing rudimentary reading and spelling repertoires are clear (see Sidman, 1994), the naming hypothesis (Horne & Lowe, 1996) and relational frame theory (Hayes et al., 2001) also have much to offer a technology of derived stimulus relations. For example, both theories focus on a history of reinforcement for responding relationally with multiple exemplars before a more generalized form of relating emerges with novel stimuli in the absence of reinforcement. Thus, both theories suggest that relational skills should generalize to a wide range of stimuli and a wide range of tasks following instruction with multiple exemplars. This is a noteworthy outcome, because behavioral approaches to education have been criticized for their focus on rote learning as opposed to teaching for generalization (Alessi, 1987).

Given the growing demand for evidence-based practices and the legislation that has mandated it, the time may be particularly ripe for the applied research program on derived stimulus relations to burgeon. The No Child Left Behind Act has made states and schools responsible for student progress, urging the use of scientifically verified instructional practices and encouraging responsible use of resources (Wright, Wright, & Heath, 2009). Similarly, Response to Intervention (Hale, 2008) prescribes the delivery of research-based instruction and the regular monitoring of student performance. As a result, reimbursement for a variety of services is largely dictated by those treatments or services that produce outcomes at the most reasonable cost (Burns, Hoagwood, & Mrazek, 1999), which is a strong justification for the use of instructional approaches that "spawn novel abilities" (Critchfield & Fienup, 2008, p. 363).

Nonetheless, researchers cannot assume that interventions or educational approaches studied under laboratory conditions will automatically transfer to real-world practice settings (Chorpita, 2003). A number of important differences often exist between research and practice settings. These differences have the potential to render educational approaches or interventions that were shown to have robust effects under tightly controlled laboratory conditions ineffective in practice settings (Hoagwood,

Burns, Kiser, Ringeisen, & Schoenwald, 2001; Weisz, Weiss, & Donenberg, 1992). For example, evaluations of the long-term efficacy of direct instruction revealed that children who participated in direct instruction classrooms performed no better on standardized reading and math tests than children who did not participate, and in fact showed poorer comprehension skills (see Kohn, 1999). Thus, examination of the transportability of a behavioral intervention may be important before efforts are made to disseminate it (Schoenwald & Hoagwood, 2001). Rogers (1983) urged researchers to consider those contextual variables that might predict how effective an intervention is in practice, including, for example, characteristics of the clients, setting, equipment, and various aspects of the procedures themselves (Chorpita, 2003). For this reason, examination of variables that may have some relevance to the context of the practice setting may be important in evaluating the transportability of an intervention to practice settings. Because federal agencies urge dissemination to increase the prevalence of evidence-based practice (Schoenwald & Hoagwood, 2001), these analyses are likely to aid in the further development and dissemination of a technology.

If the research program on derived stimulus relations is to be utilized by practitioners, a careful analysis of the applied investigations on the topic may reveal much about the technology's potential for dissemination. By examining various aspects of the studies reported to date, we may learn much about the conditions (e.g., settings, populations, tasks) under which instructional protocols based on derived stimulus relations promise success. To this end, the purpose of this descriptive analysis was to examine the studies conducted on derived stimulus relations published in *JABA*. Self-studies of this sort have been conducted on a variety of topics in the discipline (e.g., Northup, Vollmer, & Serrett, 1993). Painting a picture of where applied behavior analysis has been and where it is going, as represented in the pages of *JABA,* may thus provide an important context for future directions (Northup et al., 1993). I examined every study on stimulus equivalence or derived stimulus relations published in *JABA* and classified each article according to nine specific characteristics that I believed to be relevant to the further development of this teaching technology. Some, but not all, of the characteristics examined for each study were pertinent to issues of dissemination and transportability (e.g., Chorpita, 2003; Rogers, 1983), whereas others were thought to be relevant to future research questions aimed at expanding the scope of this technology.

The characteristics, not necessarily in the order examined, were as follows. First, I examined the characteristics of participants in each study to discern the ages, diagnoses, and skill deficits, if any, of participants with whom a derived stimulus relations technology has been used successfully. This information will help to determine whether particular populations seem to be more prepared to benefit from educational or clinical approaches based on derived stimulus relations, as well as to highlight less studied populations that should be targeted in future research. Second, I examined the instructional stimuli employed in each study in terms of both their sensory modality and arbitrariness. Identifying the sorts of stimuli employed may help to market derived stimulus relations technology to practitioners, depending on the types of skill sets that have typically been established in published reports. Although arbitrarily configured stimuli are often used in basic laboratory investigations to control for history effects, positive outcomes using real-world instructional stimuli may well enhance the disseminability of this technology (see Rogers, 1983). Third, I examined what relations were targeted in the study, including equivalence or sameness and other types of relations, such as opposition, more than, and less than. Fourth, I identified the emergent skills documented at the end of

each study. These examinations allowed a determination of what sorts of practical skills might be established if practitioners employed a derived stimulus relations protocol. For example, would a participant show the ability to rank items in terms of value at the conclusion of an instructional protocol or to match equivalent items in a match-to-sample procedure?

Fifth, I examined whether a given study assessed generalization across novel stimuli or tasks. A technology that promotes generalization of skills to untrained response topographies or novel stimuli and tasks may have wide appeal for practitioners who do not have the time or resources to instruct every desired skill directly (see Stromer et al., 1996). Sixth, I recorded whether or not the study evaluated the long-term maintenance or stability of emergent performances. How long emergent behaviors are maintained may reflect the importance of the behaviors in the daily lives of the study's participants (Cooper, Heron, & Heward, 2007), as well as the long-term sustainability of the intervention employed (Rogers, 1983). Seventh, I explored whether an automated or tabletop procedure was used in the study. One could argue that either approach is more or less transportable than the other. Unfortunately, a number of practice settings do not have the resources to ensure that all students can benefit from a computerized protocol, but computerized protocols are easily transported in the form of software or internet downloads and improve on some of the issues with procedural reliability that are inherent in tabletop procedures. Eighth, I examined the setting in which the study was conducted. Although a laboratory-based study may have extraordinary clinical and educational implications, exploring the effectiveness of an innovation in an actual practice setting may facilitate its diffusion.

METHOD

The data set included 26 empirical articles on stimulus equivalence and derived stimulus relations published in *JABA* between 1992 and 2009. Twenty-three articles were identified via a search on the journal's website (http://seab.envmed.rochester.edu/jaba). Search terms included *stimulus equivalence, symmetry relations, derived stimulus relations, relational responding,* and *relational frame theory.* To be certain that all articles on this topic were identified via this initial search, a second search was conducted using PsycInfo with the same search terms. Three additional articles were in press in *JABA* during the time in which this review was conducted. These articles were identified and provided by the editor.

All articles were reviewed and classified along nine specific characteristics, as follows: (a) participants (ages, diagnoses, and identified learning deficits, if any); (b) stimuli; (c) stimulus sensory modalities; (d) type of relation established (i.e., relations of sameness or equivalence or other types of relations, e.g., opposition, more than, and less than; (e) emergent skills; (f) generalization across novel stimuli or tasks; (g) maintenance; (h) procedure (automated or tabletop); and (i) setting.

A second recorder independently reviewed eight (31%) of the articles included in this review and recorded descriptive data for each of these nine characteristics. An agreement was scored for each characteristic if the second recorder recorded the same information as the first recorder. Interobserver agreement was calculated by dividing agreements by disagreements plus agreements and multiplying by 100%. Resulting mean interobserver agreement was 93%.

RESULTS AND DISCUSSION

Participants

Table 1 shows that 12 (46%) of the studies were conducted with participants who had a diagnosed developmental disorder, including brain injury, intellectual disabilities, Down syndrome, and autism (e.g., K. J. Saunders, O'Donnell, Vaidya, & Williams, 2003; Stromer

Table 1
Selected Characteristics of Studies

	Number of studies	Percentage of sample
Participants		
Developmental disabilities	12	46
Typically developing children with academic deficits	5	19
No disabilities or deficits	8	31
Pathological gamblers	1	4
Stimuli		
Pictures, text, or letters	14	54
Numerical or quantitative	5	19
Arbitrary	3	12
Monetary	4	15
Type of relation		
Equivalence	19	73
Comparative	6	23
Opposition	1	4
Generalization		
Reconfigurations or dimensional variants of training stimuli	9	35
Novel tasks	5	19
Novel stimulus sets	3	12
Setting		
School	8	31
University laboratory or clinic	7	27
Habilitation	3	12
Homes	2	8

& MacKay, 1992). In addition, five (19%) studies were conducted with typically developing children who had been identified as experiencing academic difficulties (e.g., de Rose, de Souza, & Hanna, 1996; Lynch & Cuvo, 1995). Thus, the majority of applications have been conducted with persons with disabilities or learning deficits, consistent with other publication trends in the study of verbal behavior (e.g., Dixon, Small, & Rosales, 2007). Eight studies (31%) included participants for whom educational or clinical deficits were not the basis for inclusion, one of which was conducted with children (Johnson & Dixon, 2009). These results underscore the benefits of a technology based on derived stimulus relations in special education and habilitative settings, but they also emphasize its utility in constructing repertoires in persons without disabilities or educational deficits. For example, four studies explored how standard instructional approaches might be supplemented by derived stimulus relations protocols in higher education (Fields et al., 2009; Ninness et al., 2005, 2006; Ninness, Dixon, et al., 2009; see also Critchfield & Fienup, 2008). Interestingly, only one (4%) study (Dixon & Holton, 2009) employed participants with a clinical disorder (in this case, pathological gambling). Thus, few researchers publishing in *JABA* have been encouraged by Hayes and Hayes (1993), who called for more research on the role of derived stimulus relations in psychopathology.

Stimuli

Table 1 shows that 14 (54%) of the studies published in *JABA* employed pictorial or textual stimuli, including printed words or single letters (e.g., Cowley, Green, & Braunling-McMorrow, 1992; Mueller, Olmi, & Saunders, 2000). Five (19%) studies used numerical stimuli, including printed numerals represented as ratios, fractions, and pictorial representations (i.e., pie charts) of fractions and ratios (Lynch & Cuvo, 1995); trigonometric formulas and graphs; and line graphs depicting statistical interactions and textual definitions, as well as names and descriptions of those interactions (e.g., Ninness et al., 2005, 2006; Ninness, Dixon, et al., 2009). Three (12%) studies employed arbitrarily configured stimuli or stimuli that were not related to other stimuli extraexperimentally (e.g., Murphy & Barnes-Holmes, 2009). Four (15%) studies used stimuli related to monetary values (i.e., coins and dollar bills) and nonmonetary stimuli that could be ordered along a continuum from least to most (i.e., differing sizes of food items) (e.g., Zlomke & Dixon, 2006). These results suggest that the majority of applications of derived stimulus relations have occurred in the context of building basic vocabulary and reading skills. Thus, behavior analysts should be well prepared to implement reading and spelling curricula based on this paradigm (see de Souza, de Rose, & Domeniconi, 2009).

These results are encouraging. Although arbitrarily configured stimuli are often employed to control for history effects, practitioners may be more inclined to adopt a protocol if the tasks and stimuli are relevant for their setting (see Rogers, 1983). Although only a few studies have explored the role of relational responding in basic and advanced math instruction, its utility seems apparent in this domain as well. Future research should focus on how programming for relational repertoires may enhance the acquisition of mathematical concepts in young children and adult learners, given the growing concern over the performance of American students in mathematics (see Ninness, Holland, et al., 2009).

Stimulus Modalities

Sixteen (62%) of the studies employed all visual stimuli (e.g., Kennedy, Itkonen, & Lindquist, 1994), and 10 (38%) studies included both auditory and visual stimuli (e.g., Rehfeldt & Root, 2005). That fewer studies included auditory stimuli is surprising, given how critical the formation of auditory–visual stimulus relations is for understanding spoken language. No studies included stimuli of other sensory modalities, but Toussaint and Tiger (2010), which was not included in this review, established stimulus relations between auditory and tactile stimuli in persons with vision impairments, thus identifying a role for the stimulus equivalence paradigm in braille instruction (see also Bush, 1993).

Type of Relation

Most of the studies (19, or 73%) programmed for the emergence of relations of equivalence, or sameness, with only seven (27%) studies targeting more complex relations (Table 1). These include Zlomke and Dixon (2006), Berens and Hayes (2007), Hoon, Dymond, Jackson, and Dixon (2008), Johnson and Dixon (2009), Murphy and Barnes-Holmes (2009), and Dixon and Holton (2009), all of which programmed for the emergence of comparative (i.e., more than and less than) relations, and Ninness, Dixon, et al. (2009), which targeted relations of both sameness and opposition. Thus, relatively few studies published in *JABA* have demonstrated the formation of relations other than sameness or equivalence. This may be due in part to the fact that many studies have used young children or participants with cognitive deficits for whom repertoires of sameness are more easily attained. However, even very early academic tasks, such as telling time, measurement, and basic arithmetic, require a child to derive comparative relations. In addition, with several research programs focusing on the application of derived stimulus relations procedures in college instruction (e.g., Fields et al., 2009; Ninness et al., 2006), further investigation of relations other than sameness is warranted (e.g., many college courses require students to ''compare and contrast,'' a skill that undoubtedly involves responding relationally in accordance with frames of opposition and comparison). Berens and Hayes (2007) provided the impetus for further research in this area by showing how the direct training of comparative relations resulted in children's derivation of comparative relations with novel stimuli, thus supporting the notion of relating as generalized operant behavior. (The reader is also referred to Luciano, Rodrigquez, Manas, & Ruiz, 2009, for curricular recommendations.) Thus, research that illustrates the practical applications of relations other than sameness or equivalence is in order.

Emergent Skills

Every study in this review documented the emergence of untrained relations using a match-to-sample test format, which requires selection-based responding (Michael, 1985). Thirteen (50%) of the studies demonstrated the emergence of some portion of skills consistent with the original Sidman (1971) paradigm, including picture naming, oral reading of sight words, matching words to pictures and pictures to words, and constructed-response spelling, in

which printed words were copied via the assemblage of anagram letter tiles (e.g., Lane & Critchfield, 1998; Melchiori, de Souza, & de Rose, 2000). Other emergent relational skills included manding or requesting (Murphy & Barnes-Holmes, 2009; Murphy, Barnes-Holmes, & Barnes-Holmes, 2005; Rehfeldt & Root, 2005; Rosales & Rehfeldt, 2007) and engaging in activities specified by textual stimuli in activity schedules (Miguel, Yang, Finn, & Ahearn, 2009). Berens and Hayes (2007) used a variety of relational tasks to evaluate the emergence of more than and less than relations (e.g., "Which would buy you more candy?"). Although they did not necessarily show an emergent skill per se, Zlomke and Dixon (2006), Hoon et al. (2008), and Johnson and Dixon (2009) showed how a history of relational responding could alter participants' preferences for slot machines or playing dice. Likewise, Dixon and Holton (2009) showed how a preference for reinforcement in a delay-discounting task could be influenced by the establishment of more than and less than relations.

Thus, the emergence of untrained stimulus relations in a match-to-sample test format was clearly the most frequently employed measure of emergent skills. Most other emergent skills pertained to the basic Sidman (1994) picture naming, reading, and spelling paradigm. In addition to examining the emergence of untrained stimulus relations, future studies should explore the emergence of skills in topographies other than match to sample. Some authors have argued that the verbal community more frequently demands topography-based responding (e.g., speaking, writing, spelling, and signing) rather than selection-based responding, which is reinforced during match-to-sample training (Michael, 1985; Perez-Gonzalez, Herszlikowicz, & Williams, 2008).

Generalization

The studies published in *JABA* evaluated generalization to novel variants of stimuli that were presented during training and to novel test formats or tasks. Just over half the studies surveyed (65%) evaluated one form of generalization. Nine (35%) studies showed that emergent stimulus relations generalized to include stimuli that were reconfigurations or dimensional variants of original training stimuli (e.g., Lynch & Cuvo, 1995; Melchiori et al., 2000) (Table 1). Test stimuli included, for example, novel words that were recombinations of words that had been presented during training (e.g., de Rose et al., 1996) and novel graphs or mathematical formulas (e.g., Ninness, Dixon, et al., 2009). Five (19%) studies showed that relational repertoires generalized to novel tasks that had some relevance for participants outside the context of match-to-sample training and testing (e.g., Berens & Hayes, 2007; Lane & Critchfield, 1998).

For example, Cowley et al. (1992) questioned whether participants would be able to locate therapists using a written list of names after the written names were shown to be equivalent to spoken names and pictures of the therapists. Likewise, Stromer et al. (1996) evaluated whether participants could use written lists to retrieve objects from a nearby shelf following a similar training procedure. Lane and Critchfield (1998) examined whether participants would identify letters that had been conditionally related to their spoken names in the context of novel four-letter words. Fields et al. (2009) showed that college students displayed superior performance on a paper-and-pencil multiple-choice statistics test relative to their pretest performance after completing an automated equivalence protocol that established relations among names, figures, definitions, and examples of statistical interactions.

In three (12%) studies, participants related novel sets of stimuli in similar ways in the absence of reinforcement after a history of reinforcement for relating instructional stimuli in particular ways (Berens & Hayes, 2007; Murphy et al., 2005; Ninness, Dixon, et al.,

2009). Berens and Hayes (2007), for example, explicitly taught more than and less than relations and found that participants responded in accordance with frames of comparison with novel sets of stimuli across a variety of tasks. These results suggest that a history of multiple-exemplar training for relating instructional stimuli in particular ways promotes responding that generalizes across a range of novel stimuli and tasks (Hayes et al., 2001).

In underscoring the powerful role for a technology of derived stimulus relations in applied settings, the generalization results from the *JABA* studies are probably the most significant, because they illustrate the many educationally significant outcomes that may occur well beyond the context of match to sample. However, 12 (46%) of the studies did not evaluate generalization. Successful generalization performances may in fact be among the most important of the characteristics examined in terms of the transportability of a study's procedures and findings. A procedure that generates novel performances in a variety of situations or tasks is likely to have important implications for a student or client when used in a practice setting. Applied researchers should continue to think beyond the generation of emergent match-to-sample performance to other repertoires that a history of reinforced relational responding might produce.

Maintenance

Only three (12%) of the studies evaluated the maintenance of emergent skills (Lane & Critchfield, 1998; Ramirez & Rehfeldt, 2009; Rosales & Rehfeldt, 2007). This finding is discouraging, particularly in light of Rogers' (1983) argument that the sustainability of an intervention is critical to its diffusion. Although instructional paradigms that program for the emergence of a relational repertoire are economical and efficient and may result in a range of untrained skills, the skills are of no value if they are not maintained over time. Basic laboratory work has shown that derived stimulus relations may be remarkably stable over time (Rehfeldt & Hayes, 2000; R. R. Saunders, Wachter, & Spradlin, 1988), but these findings cannot be taken for granted in practical settings. Future studies should routinely include follow-up probes. Moreover, the amount of retraining necessary to recapture relational skills that are not maintained is a worthwhile area of investigation.

Automated or Tabletop Procedures

Seventeen (65%) of the studies used automated procedures (e.g., Hoon et al., 2008), and 10 (38%) used tabletop procedures (e.g., Murphy et al., 2005). Stromer et al. (1996), who established constructed-response spelling repertoires in adults with intellectual disabilities, used both automated and tabletop procedures. That fewer studies used tabletop procedures is noteworthy, because some educational settings may not have the resources for all students to complete automated protocols on a regular basis. In addition, tabletop procedures may be more easily incorporated into small-group instruction. Finally, further development and refinement of tabletop procedures may identify effective approaches for teaching staff to implement derived stimulus relations protocols (e.g., Sarokoff & Sturmey, 2004).

Setting

Not all studies reported the setting in which the study was conducted. Of those that did, eight (31%) were conducted in school settings (e.g., Connell & Witt, 2004), seven (27%) were conducted in university laboratories or clinics (e.g., Ninness et al., 2005), and three (12%) were conducted in adult service agencies or habilitation settings (e.g., Rosales & Rehfeldt, 2007) (Table 1). Ninness et al. (2005) conducted sessions in a hospital setting, and Berens and Hayes (2007) and Johnson and Dixon (2009) conducted some sessions in participants' or experimenters' homes. Thus, most studies were conducted in school or university laboratory settings. Although the instructional sessions

conducted in school and agency settings may have been run by graduate assistants and not teachers or staff, conducting studies in these settings may play a small but not insignificant role in the dissemination of this technology to practitioners.

In summary, this descriptive analysis inspired a number of recommendations for future research, many of which may enhance the transportability of the derived stimulus relations research program to practitioners. First, more research examining the efficacy of derived stimulus relations protocols with nondisabled populations (e.g., typically developing students of all ages) seems to be in order, as does the role of relational behavior in the genesis of psychological disorders. Second, although the utility of relational learning in early reading instruction has been ascertained, examining its role in more advanced reading and other areas of academics, including mathematics, is warranted. Third, individuals with sensory impairments might benefit from derived stimulus relations protocols that capitalize on other senses (e.g., touch; Toussaint & Tiger, 2010). Fourth, researchers need to look beyond the establishment of relations of sameness, particularly if the paradigm is to have any utility in the instruction of more complex skill areas. Protocols for establishing frames of comparison and opposition need to be examined (Luciano et al., 2009), along with protocols for establishing deictic frames, or frames that specify a relation in terms of the perspective of the speaker, which may be critical for teaching perspective taking (Hayes et al., 2001). Fifth, promoting the emergence and generalization of topography-based skills that are displayed under a variety of novel conditions and test formats is critical. Sixth, follow-up probes should be conducted as a standard practice. Seventh, future research should examine how tabletop protocols might be incorporated into small-group instruction, because they are more likely than automated procedures to be adopted in many educational settings. Finally, strategies for disseminating this technology, be they workshops, training manuals, or publications in practitioner-oriented journals, must be implemented if the paradigm is to have the socially significant outcomes initially predicted (Stromer et al., 1996).

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