



Provided by the author(s) and University of Galway in accordance with publisher policies. Please cite the published version when available.

Title	Education, intellectual development, and relational frame theory
Author(s)	Stewart, Ian; Roche, Bryan; O'Hora, Denis; Tarbox, Jonathan
Publication Date	2013-05-01
Publication Information	Stewart, Ian, Roche, Bryan, O'Hora, Denis, & Tarbox, Jonathan. (2013). Education, intellectual development, and relational frame theory. In Simon Dymond, Bryan Roche & Jan De Houwer (Eds.), <i>Advances in Relational Frame Theory: Research and Application</i> . Oakland: New Harbinger Publications.
Publisher	New Harbinger Publications
Link to publisher's version	https://www.newharbinger.com/advances-relational-frame-theory
Item record	http://hdl.handle.net/10379/7038

Downloaded 2024-04-18T05:27:35Z

Some rights reserved. For more information, please see the item record link above.



Chapter 9

Education, intellectual development, and relational frame theory

Ian Stewart, PhD.

National University of Ireland, Galway

Bryan Roche, PhD.

National University of Ireland, Maynooth

Denis O’Hora, PhD.

National University of Ireland, Galway

Jonathan Tarbox, PhD.

Center for Autism And Related Disorders

[A] Introduction

As has been laid out in previous chapters of the current volume, Relational Frame Theory maintains that arbitrarily applicable relational responding or relational framing is the core behavior that characterizes human language and cognition. Thus, from this perspective, the capacity to frame relationally should correlate with linguistic and cognitive performance and thence also with both intellectual ability and educational attainment; furthermore, by training relational framing, intellectual performance and educational attainment should be enhanced.

When the first edited volume on RFT was published in 2001, there was already evidence of a link between verbal ability and coordinate framing in the form of stimulus equivalence. However, there was very little work investigating other types of relations and there was no empirical evidence demonstrating that relational framing correlated with intellectual ability as typically measured. In their chapter on education, Barnes-Holmes, Barnes-Holmes & Cullinan (2001) suggested that multiple exemplar training (MET) of relational framing might lead to improved linguistic and intellectual performance. However, at that time there had as yet been no published

work demonstrating the efficacy of MET even for improving relational framing itself, let alone showing that training the latter might lead to improvements in cognition and / or intelligence. After an additional decade of RFT research conducted in the meantime, however, there have been impressive advances in all these respects. In the current chapter we will explore these advances and examine where we are now and where we need to go next.

[A] Correlations between Relational Framing and Linguistic and Cognitive Abilities

[B] Coordination (2001-2011)

According to RFT, coordinate (or sameness) framing is absolutely fundamental in our language since it underlies linguistic reference. From this perspective, a well-honed ability to respond to and derive frames of coordination is crucial for the acquisition of a broad and well-organized vocabulary. The latter is a basic prerequisite to normal language development, the extent of which is both predicted by and predicts general intelligence.

As mentioned above, in 2001 there was already evidence that coordinate framing, correlated with verbal ability. For example, research had shown that while humans with even minimal verbal ability seemed to readily demonstrate stimulus equivalence, non-humans and non-verbally able humans did not do so (e.g., Barnes, McCullagh, & Keenan, 1990; Devaney, Hayes & Nelson, 1986; Dugdale & Lowe, 1990, 2000; Sidman, 1971; Sidman, Rauzin, Lazar, Cunningham, Tailby & Carrigan, 1982; though see also Schusterman & Kastak, 1993). Furthermore, empirical effects such as semantic priming had been shown for stimuli in equivalence relations (e.g.,

Hayes & Bissett, 1998) and similar patterns of neural activity had been found for derived equivalence as for linguistic processing (e.g., Dickins, Singh, Roberts, Burns, Downes, Jimmieson & Bentall, 2001).

Over the last decade, further evidence of the correlation between relational framing and linguistic and cognitive abilities has emerged. Many of the relevant studies have continued to feature coordinate framing. For example, Barnes-Holmes et al. (2005) reported that derived equivalence by typically developing adults both showed semantic priming effects and also produced an event-related potentials (ERPs) signature similar to that for language processing; O'Connor, Rafferty, Barnes-Holmes & Barnes-Holmes (2009) showed that (CABAS system-based) verbal competence of children with ASD correlated with derived equivalence performance; while Moran, Stewart, McElwee & Ming (2010) showed that scores on the communication subscale of the Vineland Assessment of Behavior Scales (VABS) of children with ASD also correlated with equivalence.

A number of RFT studies since 2001 have demonstrated a link between derived relational responding and cognitive performance by using derived relational procedures to teach educationally relevant skills. Not surprisingly, given its fundamental importance and prevalence in behavior analytic research, most of this work has involved coordinate (equivalence) framing and this work is also relevant under the current heading. For example, Leader and Barnes (2001) taught children fraction-decimal equivalence using a respondent-type training procedure and also showed generalization to several new task contexts. A series of more recent studies has focused on transfer of functions via equivalence relations and in particular on the transfer of the practically important 'mand' response. The concept of the mand is a behavioral analysis of the controlling variables present when someone asks for

something they want (Skinner, 1957). Technically speaking, a mand is a verbal operant that is under the antecedent control of motivating operations and that specifies its reinforcer (e.g., the request “cookie” is reinforced by receiving a cookie). A number of studies have demonstrated the efficacy of equivalence procedures in allowing this important skill to transfer rapidly to a variety of new contexts (e.g., Rehfeldt & Root, 2005; Murphy, Barnes-Holmes & Barnes-Holmes, 2005; Murphy & Barnes-Holmes, 2009a & b).

As this review suggests, research on equivalence relations has contributed substantially to the empirical evidence supporting the correlation between derived relations and intellectual performance. However, in the last decade in particular, this evidence has been supplemented by evidence from studies that have demonstrated the correlation between non-coordinate relational framing performance and linguistic and cognitive ability. These have included studies of temporal (before / after), comparative (more / less), analogical and deictic framing.

[B] Temporal Relations

Temporal relational framing involves responding under the control of the contextual cues ‘Before’ and ‘After’ or their functional equivalents. This form of framing underlies the capacity to coordinate with other individuals and society more generally with regard to the conventionally important dimension of time.

A series of studies have investigated the correlation between temporal relational responding and performance on standard measures of intelligence. The first such study was by O’Hora, Pelaez & Barnes-Holmes (2005). These researchers divided college student volunteers into 2 groups on the basis of their performance on a complex relational task that involved responding in accordance with temporal, sameness and distinction relations (see also O’Hora, Barnes-Holmes, Roche, &

Smeets, 2004) before subsequently exposing them to the vocabulary, arithmetic, and digit-symbol encoding subtests of the Wechsler Adult Intelligence Scale (3rd edition). Those successful on the relational task showed superior performance on both the vocabulary and arithmetic subscales in relation to those who had failed, while there was no difference on the digit-symbol encoding subtest. Since both of the latter contribute to verbal proficiency sub-scores while the latter does not, it was argued that this provided further evidence of the relevance of relational framing to verbal behavior in particular. In a more recent follow up study, O’Hora, Pelaez, Barnes-Holmes, Rae, Robinson & Chaudhary (2008) compared performance on the same relational task with performance on the entire WAIS-III and showed that successful completion predicted superior performance on both the verbal comprehension and perceptual organization indices, but not on the working memory or processing speed indices. This finding cohered with pre-experimental hypotheses since both the former indices can be argued to rely more substantively on relational framing than either of the latter, and it also provided further confirmation of the importance of relational framing as the process underlying language.

In a more recent study, O’Toole & Barnes-Holmes (2009) used the Implicit Relational Assessment Procedure (IRAP), a methodology that enables measurement of speed of relational responding, to examine framing in accordance with sameness, distinction and temporal relations and to compare performance in these frames with performance on the Kaufman Brief Intelligence Test (K-BIT). For each relational task, reaction times were measured first on consistent trials, which required responses in accordance with pre-established verbal relations, and then on inconsistent trials, which required responding against those relations. A difference-score was calculated by subtracting consistent from inconsistent response latencies. The inconsistent trials

and the difference-score provided measures of relational flexibility. Results showed that faster responding on the IRAP and smaller difference-scores predicted higher IQ. These findings provided further evidence of the correlation between relational framing and intellectual performance and suggested in particular the importance of flexibility in relational framing as a predictor of intelligent behavior.

[B] Comparison

Comparison relations are involved 'whenever one event is responded to in terms of a quantitative or qualitative relation along a specified dimension with another event' (Hayes, Fox, Gifford, Wilson, Barnes-Holmes & Healy, 2001). Comparison relations are critically important in mathematics and also in our everyday language, which includes diverse sub-types (e.g., faster-slower, older-younger, better-worse etc.). Hence, this frame is particularly important from an educational point of view. A number of studies since 2001 have investigated the relational frame of comparison. Some of these have focused on training comparative relations and these will be reviewed later on in this chapter. Others have demonstrated a correlation between comparative relational framing and cognitive performance as assessed by mainstream cognitive psychology and thus are relevant to our current enquiry.

One of the latter studies was by Reilly, Whelan & Barnes-Holmes (2005). These researchers investigated the effect of differential training histories on contextually controlled comparative relational framing. Adult volunteers' responding to non-arbitrary stimulus relations of 'more than' and 'less than' was first brought under contextual control. They were then exposed to training with arbitrary stimuli that either involved all 'more than' trials, all 'less than' trials or a mixture of both before being tested for a variety of trained and derived relations. They found that latencies were significantly lower for those given all 'more than' training than for

those given either of the other types of training. This superiority in respect of ‘more than’ relations accords with previous studies on relational inferences reported in mainstream cognitive studies.

A second relevant study was conducted by Munnely, Dymond and Hinton (2010) who used comparative relational framing as a model of the phenomenon of transitive inference. Contextual functions of ‘more than’ and ‘less than’ were first established for two arbitrary stimuli. Then, one group of participants was trained in a series of arbitrary ‘more than’ relations, while a second group was trained in a series of arbitrary ‘less than’ relations. Finally, both groups were exposed to inferential tests of mutual and 1- and 2-node combinatorial entailed relations. Both groups performed equally well in terms of overall accuracy. However, both groups showed differences in accuracy on both 1- and 2-node combinatorial entailed tasks based on whether the tested relation was the same as or different from those trained. Overall their findings replicated several important effects from the transitive inference literature.

As mentioned earlier, a number of RFT studies since 2001 have shown a link between derived relations and cognitive performance by using derived relational procedures to teach educationally relevant skills. One such study in the area of comparative relational framing was by Murphy and Barnes-Holmes (2010) who demonstrated the transformation via comparative relations of derived manding functions in four adolescents with autism and three typically developing children. More and less functions were first established for two arbitrary stimuli X and Y respectively and then these were employed to establish a linear network of comparative relations among a further five arbitrary stimuli. Results of subsequent tests showed a derived transformation of functions for several participants.

[B] Analogical Relations

Analogy is a fundamentally important element of human cognition. It is a critical tool for purposes of communication in educational and scientific contexts and is also commonly employed as a metric of intelligent behavior. As such, RFT research into analogical reasoning is vital with respect to the provision of comprehensive relational framing based intervention in the educational realm.

Barnes, Hegarty & Smeets (1997) provided the first relational frame model of analogy as deriving a relation of sameness between sameness relations ('equivalence-equivalence responding'). This model was demonstrated primarily with adults. Since 2001, that work has been extended with a series of studies comparing analogical relational framing in different age groups including adults, nine year olds and five year olds. Carpentier, Smeets & Barnes-Holmes (2002) showed that whereas the latter two groups could readily show equivalence-equivalence, the five years olds could not show it unless given specific remediation training. Carpentier, Smeets & Barnes-Holmes (2003) extended these findings by showing that, in contrast with both other age groups, five year olds were also unable to demonstrate equivalence-equivalence under any circumstances unless first tested for equivalence relations. Both these sets of results suggested a developmental divide between early and late childhood similar to that reported in some mainstream developmental research on analogical reasoning (e.g., Sternberg & Rifkin, 1979).

The conclusion that children in early childhood are unable to demonstrate analogy is disputed by other mainstream researchers (see e.g., Goswami, 1991). However, in more recent work, RFT researchers have provided evidence that suggests that apparently successful analogical responding as demonstrated by children younger than 5 years of age might be based on processes other than matching functionally same relations (Carpentier, Smeets, Barnes-Holmes & Stewart, 2004). This additional

evidence supports the original conclusion from RFT research as well as that of the developmental research with whose conclusions it agreed. Thus in this domain, RFT research has shown that empirically generated relational framing parallels and can model linguistic phenomena and that work using relational framing to do so can add unique and valuable new insight into key aspects of human cognition.

More recent studies with adults have provided additional evidence that equivalence-equivalence or coordinate framing of relations provides a good model of analogical reasoning. Two of these in particular are noteworthy. Barnes-Holmes et al. (2005) examined event-related potentials (ERPs) associated with coordinate framing of both same and difference relations. For both patterns, they found activity in the bilateral prefrontal brain regions, especially the dorsolateral areas, which parallels the findings of studies that have examined the neural substrates of natural language analogy (e.g., Luo, Perry, Peng, Jin, Xu, Ding & Xu, 2003). They also noted ERP effects in the right hemisphere. Previous work on analogy has noted that right hemispheric activity appears to be a special feature of this form of responding that marks it out from linguistic activity more generally which is associated with the left hemisphere (Luo et al., 2003). The fact that this specific effect was also reproduced by Barnes-Holmes et al. (2005) provides particularly good support for the RFT model of analogy. Ruiz and Luciano (2011) extended the RFT model of analogy by training and testing ‘cross-domain’ analogy as the relation of relations in separate relational networks. More importantly from the current perspective, however, they also demonstrated that participants’ performance on this model of analogy strongly correlated with that on a standard measure of analogical reasoning.

[B] Perspective Relations

Relational frame theory approaches perspective taking as arbitrarily applicable relational responding under the control of the contextual cues I-YOU, HERE-THERE and NOW-THEN, or their functional equivalents. Published research examining this form of responding, which is also known as deictic (i.e., based on the perspective of the speaker) relational framing first began to emerge only in 2004 but since then there has been a substantive amount of work in this area. This has included a series of studies that has provided evidence of the correlation between deictic framing and perspective taking as conceptualised in the mainstream literature as well as cognitive ability more generally.

McHugh, Barnes-Holmes and Barnes-Holmes (2004) investigated the development of perspective-taking as deictic framing in a range of age groups from early childhood to adulthood. Findings indicated that accuracy increased as a function of age, supporting the concept of the operant nature of this phenomenon. In addition, findings showed overlap with those of both mainstream developmental as well as Theory of Mind (ToM) research. In respect of the latter, they found that HERE-THERE relations tend to emerge before NOW-THEN relations, which coheres with evidence that young children master spatial relations before temporal relations. With regard to Theory of Mind, the literature in this domain argues that performances on simple ToM tasks should improve between four and five years old (Baron-Cohen et al., 2000). The findings from McHugh et al. in which the performances of children in their middle childhood more closely resembled those of older participants than those of the youngest age group accorded with this claim.

There is also evidence from studies of individuals in clinical categories associated with deficits in perspective taking ability that demonstrate the correlation between deictic framing performance and the latter. Rehfeldt, Dillen, Ziomek and

Kowalchuk (2007) found that children with autistic spectrum disorder (ASD) showed deficiencies in deictic framing in comparison with typically developing children. They also showed that accuracy on NOW THEN framing correlated with scores on the Daily Living Skills domain of the Vineland Adaptive Behavior Scales, a standardized instrument commonly used in the assessment of ASD. Villatte, Monestes, McHugh, Freixa I Baque & Loas (2010a) found poorer performance of participants with schizophrenia than age matched controls in responding in accordance with complex deictic framing tasks. They also found that performance on the latter was a strong predictor of accuracy on the so called mental states attribution task, a mainstream measure of perspective-taking. Villatte, Monestes, McHugh, Freixa I Baque & Loas (2010b) found poorer performance of both clinical participants with schizophrenia and sub-clinical participants with social anhedonia on deictic framing tasks.

The results just described further support the contention that deictic relational framing is a core process underlying perspective taking ability. One other recent study shows the correlation between deictic framing and cognitive performance more generally. Gore, Barnes-Holmes & Murphy (2010) exposed 24 adults with varying levels of intellectual disability to standard measures of language and IQ, as well as to an adaptation of the McHugh et al. (2004) deictic framing protocol and found that perspective-taking correlated with verbal ability, full-scale IQ and performance IQ.

[A] Training Relational Framing

The research just reviewed provides evidence for a variety of forms of relational framing and shows both how specific forms of framing are linked with specific cognitive abilities as well as how framing in general correlates with linguistic

and cognitive ability in general. This supports the RFT contention that relational framing is the core repertoire underlying intellectual performance. Furthermore, it suggests that by targeting this repertoire for training, we can improve performance in educational and other domains in which intellectual performance is important. As indicated earlier, Barnes-Holmes, Barnes-Holmes & Cullinan (2001) made the argument that multiple exemplar training (MET) of relational framing could improve linguistic and intellectual performance. At the time they made this argument, there was no published work demonstrating the efficacy of MET even for improving framing itself, let alone showing that targeting this repertoire might improve cognition and intelligence. In the ten years since, however, there have been substantial advances in these respects. In what follows we will review RFT research on multiple exemplar training of a variety of relational frames that has been conducted since 2001.

[B] Coordination

The earliest published work to report the explicit use of multiple exemplar training to establish derived relations was by Barnes-Holmes, Barnes-Holmes, Roche & Smeets (2001a). The purpose of this study was to determine whether MET would readily facilitate a transformation of function in accordance with symmetry in 4-5 year old children. Across Experiments 1-3, twelve participants were trained to name a range of actions and objects and were also trained in action-object conditional discriminations (e.g., when experimenter waves, choose toy car; when experimenter claps, choose doll) and tested for derived object-action symmetry (e.g., given toy car, wave; given doll, clap), using a multiple baseline design to introduce exemplar training in symmetrical responding for participants who failed. The use of the multiple baseline design provided evidence that MET and not name training was the important variable in facilitating symmetry. In Experiment 4, an additional four

participants were trained and tested in the reverse direction from the first three experiments (i.e., object-action conditional discrimination training before testing for action-object symmetry) and once again the evidence suggested that MET was a key facilitator of symmetry. In addition, a subsequent study (Barnes-Holmes, Barnes-Holmes, Roche & Smeets, 2001b) showed that MET was equally facilitative of derived symmetry in the absence of name training.

A number of studies since these initial ones have added to the evidence of the efficacy of MET for the establishing of derived coordinate relations. Murphy, Barnes-Holmes & Barnes-Holmes (2005) provided the first example of the use of MET to establish derived equivalence responding in a developmentally delayed individual. More specifically they used it to establish transformation of mand response (discriminative) functions through equivalence relations in a child with ASD when he alone of six children failed to show the derived performance. Gomez, Lopez, Martin, Barnes-Holmes & Barnes-Holmes (2007) extended the work of Barnes-Holmes, Barnes-Holmes, Roche & Smeets (2001a & b) who had previously, as outlined, demonstrated the use of MET to facilitate mutually entailed (symmetrical) coordinate framing in 4 year old typically developing children, by successfully employing it to facilitate combinatorial entailed coordinate framing in a similar age group. Luciano, Gomez & Rodriguez (2007) investigated the respective roles of MET and naming in the emergence over several months of immediate and delayed symmetrical responding and the emergence of equivalence in the context of two and three comparison formats in a very young infant (starting age: 15 months, 24 days; age by study end: 23 months, 25 days). The repertoires targeted by exemplar training emerged in the absence of naming, which only appeared by the end of the study. Murphy & Barnes-Holmes (2010) used MET to establish derived manding in an adolescent with ASD, thus

providing another empirical demonstration of the effect first shown by Murphy, Barnes-Holmes & Barnes-Holmes (2005). Finally, most recently, Cassidy, Roche & Hayes (2011) used MET to train typically developing 8-12 year old children in equivalence relations and showed not only a significant improvement in equivalence responding itself but also in full and subscale IQ scores as measured on the Wechsler Intelligence Scale for Children (WISC-III; Wechsler, 1992).

[B] Comparison & Opposition

There have been a number of studies that have used MET for the purposes of training non-coordinate relations. The two relations that have received most of the focus are comparison and opposition. This is unsurprising since these relations are of fundamental importance and likely provide basic templates for aspects of more complex relations. For example, comparison arguably provides a basic template that lends itself to features of spatial, temporal and hierarchical relations, while opposition arguably provides a similar template with respect to deictic relations. Hence, training these relations not only teaches the relations themselves but also lays the ground for more advanced relational learning. In addition, these relations are more complex than coordination and hence can provide a more rigorous training regime in terms of improving cognitive performance.

The first study to train non-coordinate framing was Barnes-Holmes, Barnes-Holmes, Smeets, Strand & Friman (2004), who focused on comparative relations. This study also aspired to be the first to generate repertoires of relational responding when found to be absent in young children, as opposed to simply facilitating them as had likely happened in Barnes-Holmes, Barnes-Holmes, Roche & Smeets (2001a & b). In Barnes-Holmes et al. (2004), three children between 4 and 6 years were exposed to a task involving two or three identically-sized paper ‘coins’. On each trial,

the experimenter would compare the coins in terms of value and then ask the child to pick the one that would "buy as many sweets as possible". All three children failed baseline tests for specific patterns of comparative framing. Hence, MET was employed to train the appropriate, increasingly complex patterns required. Generalization tests showed that the taught patterns generalized to novel stimuli and a novel experimenter. Furthermore, evidence of the operant nature of the repertoire being trained was provided on the basis of a noted absence of improvement under conditions of non-contingent reinforcement and by demonstrating contingency reversals for all three children.

The second study to train non-coordinate framing focused on opposition relations. This study, by Barnes-Holmes, Barnes-Holmes & Smeets (2004), was a companion study to the one just reviewed, in that it employed the same three children as had been employed in that study and used the same basic task to test and train opposition relations. Children were presented with various numbers of identically sized paper 'coins' whose value relative to other coins was specified in each trial via relations of opposition and was asked which coin or coins they would choose in order to "buy as many sweets as possible". As in the study on comparative relations, all three children failed baseline tests and were subsequently trained to respond appropriately through MET. As for comparative relations, tests showed that the taught patterns generalized to novel stimuli and a novel experimenter and evidence of the operant nature of the repertoire was provided based on performance under non-contingent reinforcement conditions and by showing contingency reversals.

Berens & Hayes (2007) replicated and extended Barnes-Holmes, Barnes-Holmes, Smeets, Strand & Friman (2004) on multiple exemplar training of comparative relations by conducting a more rigorous and systematic evaluation of the

effects of MET in this context. In Barnes-Holmes et al multiple relational features of comparative framing (i.e., both mutual and combinatorial entailment based on both more and less relations) were established simultaneously and thus the effects of the acquisition of each feature on others as well as on the overall comparative frame could not be ascertained. In addition, they employed a somewhat limited set of tests for the derivation of comparative relations. Finally, the baselines that they employed were relatively short and the participants appeared to acquire the comparative frame relatively rapidly, suggesting the possibility that the training procedures merely established a context for the display of an already acquired operant rather than establishing the operant itself. Berens et al. used a combined multiple baseline and multiple probe design to conduct a more thorough analysis of the effects of MET in the context of comparative relations. A multiple baseline (across responses) design allowed the assessment of the effects of training of an array of increasingly complex aspects of the comparative relational operant (i.e., mutually entailed more, mutually entailed less, combinatorial entailed more, combinatorial entailed less, mixed non-linear more and less) on each of these aspects themselves as well as on the complete comparative frame. The inclusion of the final aspect of the comparative operant, mixed non-linear comparative relations, facilitated examination of a more advanced comparative repertoire. Finally, the use of extended baselines in the context of a multiple baseline (across participants) design allowed more clear cut evidence that the procedure was establishing the comparative frame rather than simply establishing a novel context for an already established operant.

Two recent studies that used MET to train comparative relations in individuals with developmental delay have added to evidence of the efficacy of MET for training comparative relations and relational frames more generally and provided further

support for the use of RFT-based interventions for individuals with developmental delay. Gorham, Barnes-Holmes, Y., Barnes-Holmes, D. & Berens (2009) used MET to train both typically developing children and children with autism to respond correctly on relatively advanced comparative relational tasks involving 4 'coin' stimuli, while Murphy & Barnes-Holmes (2010) used MET to train transformation of manding functions through derived comparative relations in one typically developing child and one child with autism.

The last and most recent example of a study that falls under the current heading involved the training of both the non-coordinate relations under discussion (i.e., comparison and opposition) and is perhaps one of the most impressive and convincing studies to have emerged thus far from the RFT stable, especially in respect of the potential of RFT to improve intellectual ability and further educational aims. Cassidy, Roche & Hayes (2011) were already reported in the sub-section on coordinate relations as having used MET to successfully train 8-12 year olds in equivalence relations. In fact, they trained separate groups of educationally typical and educationally sub-typical children not just in equivalence relations but also in other relations including comparison and opposition. In the case of all three types of relations, multiple exemplar training successfully improved relational framing. Furthermore, as previously indicated, relational training produced improvements in full and subscale IQ (WISC-IV; Wechsler, 2004). While, as reported, equivalence training proved to be relatively beneficial in this respect, training in multiple non-coordinate relations seemed to produce much greater improvements even than equivalence training. In Experiment 1, which focused on educationally typical children, for example, the effect size for improvement in full scale IQ after equivalence training was 0.98, while the effect size for improvement in IQ after

multiple relational training was 5.13. In Experiment 2, which involved training 8 children with educational difficulties in multiple relational training alone, full scale IQ rose by at least one standard deviation for seven of the eight children, and this change was also significant at the group level. Furthermore, follow up IQ testing conducted almost four years later showed that in all cases IQ rises were maintained well across this very large follow-up period. Overall, the findings from this study suggest the efficacy of MET of relational framing for the skill of relational framing itself as well as for intellectual performance, and point to the importance of non-coordinate framing in particular in this respect.

[B] Perspective Relations

A recent study by Weil, Hayes, and Capurro (2011) used MET to enhance deictic framing in typically developing preschool children. Children were trained in multiple exemplars of I/You, Here/There, and Now/Then relations, and training progressed from simplest to most complex relations, i.e., from simple, to reversed, and finally to double-reversed relations. Training resulted in increases in accurate performance and generalization to untrained stimuli across participants. General increases were also seen post-training on cognitive tests of perspective-taking. This study was the first to demonstrate that MET can improve derived relational responding relevant to perspective taking. The participants were typically developing children – participants who would have developed deictic framing over ensuing years without intervention. An important next step will be investigation of MET as a method for training deictic relations in populations characterized by deficits in perspective-taking, such as those with autism. In any event, this study demonstrated clearly how perspective-taking is a learned behavior that can be taught via MET.

[B] Sequential Relations

Performance on sequential relational response tasks has been shown to correlate with fluid intelligence (i.e., the ability to reason and to solve new problems independently of previously acquired knowledge; Jäeggi, Studer-Luethi, Buschkuehl, Su, Jonides & Perrig, 2010). A recent study by Baltruschat, Hasselhorn, Tarbox, Dixon, Najdowski, Mullins, and Gould (in press) used multiple exemplar training to improve performance of children with autism on a sequential relational task known as the “digit span backward” task. In this task, the experimenter vocally presented a random sequence of letters to the child and the latter was then asked to repeat the letters back to the experimenter in reverse order. Multiple exemplar training was used to improve accuracy on the task and improvements were seen in all children. Furthermore, increases in accuracy maintained after reinforcement was discontinued and generalized to untrained stimuli (letters and numbers that were not included in training).

[B] Conditional Relations

In a recent study by Tarbox, Zuckerman, Bishop, Olive, and O’Hora (2011), multiple exemplar training was used to teach six children with autism to respond to rules that described conditional relations between antecedents and behaviors, a foundational component of rule-governed behavior. Experimenters presented rules in “If/then” format, for example, “If this is a carrot, then clap your hands.” Trials randomly alternated between presenting stimuli specified in the rule (e.g., a carrot) versus stimuli that were not specified in the rule. Correct responding consisted of emitting the behavior specified in the rule when the specified antecedent stimulus was present and inhibiting the behavior when the specified antecedent was not present (e.g., not clapping if an apple was presented instead of a carrot). In baseline, none of the participants were able to consistently respond correctly. Prompting, reinforcement,

and prompt fading were used to train multiple exemplars of particular antecedent-behavior combinations. After multiple exemplar training, all participants demonstrated generalization to numerous untrained rules (i.e., rules that contained antecedents and behaviors that were never present during training). However, the number of exemplars required varied and some degree of adjustment of the original procedure was necessary for about half of the participants. Nevertheless, the study represents a promising first step in establishing conditional relational responding, as well as a first foray into establishing rule-governed behavior in individuals who do not display the repertoire.

[B] Other Relevant Work

[C] Mathematical Relations

Chris Ninness and colleagues have published a series of articles reporting the successful use of computer-interactive protocols to teach advanced mathematical skills via derived relations (Ninness, Rumph, McCuller, Vasquez, Harrison, Ford, Capt, Ninness & Bradfield, 2005; Ninness, Rumph, McCuller, Harrison, Ford & Ninness, 2005; Ninness, Barnes-Holmes, Rumph, McCuller, Ford, Payne, Ninness, Smith & Ward & Elliott, 2006; Ninness, Dixon, Barnes-Holmes, Rehfeldt, Rumph, McCuller, Holland, Smith, Ninness, & McGinty, 2009). These studies involved using matching-to-sample strategies to (i) teach formula-to-graph relations for mathematical transformations (of algebraic and trigonometric formulae) about the coordinate axes (Ninness, Rumph, McCuller, Vasquez et al., 2005); (ii) teach formula-to-factored formula and factored formula-to-graph relations for vertical and horizontal shifts on the coordinate axes (Ninness, Rumph, McCuller, Harrison, 2005); (iii) analyze and guide transformation of stimulus functions of formulae (Ninness et al., 2006); and (iv) incorporate same and opposite (reciprocal) relational control into training of

trigonometric classes involving transformation of amplitude and frequency functions (Ninness et al., 2009). These studies were particularly interesting in that they

[C] Metaphorical Relations

Metaphor is a subtype of analogy to the extent that it involves relating relational networks; however, metaphors are often more subtle and complex than analogies. In addition, they are relatively frequent in naturalistic language contexts and thus understanding and using them is an important skill to have. Another recent study on multiple exemplar training taught children with autism to solve novel metaphors (Persicke, Tarbox, Persicke, Ranick, & St Clair, 2012). Children with autism were taught to solve novel metaphors (e.g., “This apple is candy”) by talking themselves through the following steps: 1) stating the properties of the apple (e.g., it’s fruit, it grows on trees, it’s sweet), 2) stating the properties of the metaphor (e.g., “it’s food, it’s sweet, and it rots your teeth”), and 3) identifying the property shared between the two stimuli, thereby identifying the meaning of the metaphor (in this case it means the apple tastes sweet). In RFT perspective, the children were being taught to relate each stimulus in the metaphor to its properties, instances of hierarchical relating. In addition, comparing the inferred properties of the two stimuli in the metaphor consisted of relating in terms of differentiation (for properties that were not the same) and coordination (when the particular shared property was identified). All children in the study learned to solve novel metaphors and accurate responding generalized to metaphors that had never been trained, thereby demonstrating a flexible, generally applicable repertoire.

[C] Sarcasm

Sarcasm is a form of verbal irony where the intended meaning of a statement is the opposite of what is actually said. The ability to understand and respond

appropriately is important to successful social functioning because an appropriate response to a sarcastic comment is often very different from an appropriate response to a sincere comment. For example, if a child is playing basketball with his friends and he misses a shot and another child says “Wow, nice shot,” responding to the comment as though it was sincere (e.g., “Thanks,” or “No, it wasn’t a nice shot, I missed!”) would not likely be socially successful for the child.

The ability to understand sarcastic language, among many other forms of non-literal language, is impaired in individuals with autism (Pexman, Rostad, McMorris, Climie, Stowkowy, & Glenwright, 2011), but little research has attempted to teach it. RFT lends a convenient analysis in that sarcasm essentially amounts to a relation of opposition between the literal meaning of the statement and what the speaker actually means. The listener then must respond to subtle contextual cues (e.g., facial expression, tone of voice, overall likelihood that the literal meaning could be the intended meaning) by engaging in relating in terms of opposition, which results in inferring the intended meaning of the speaker, which then sets the occasion for responding appropriately.

A recent study by Persicke, Tarbox, Ranick and St Clair (in review) used multiple exemplar training to teach children with autism to engage in relating behavior of this sort, in order to discriminate between sarcastic and sincere statements and then respond appropriately. During baseline, experimenters made a variety of comments, both sarcastic and sincere, over the course of normal, unstructured conversation. All participants consistently responded as though the sarcastic comments were sincere. During treatment, participants were taught to talk to themselves about whether a person “really means” what they say, and if not, that one should respond differently than if they did. Training began in a structured format,

progressed across numerous exemplars, and gradually faded to a completely natural conversation format. At the end of the study, all participants were responding appropriately to many untrained sarcastic comments. An interesting anecdotal finding was that participants also began making their own novel sarcastic comments, although this behavior was never directly trained.

[A] Overview and Conclusion

The research reviewed in this chapter provides significant evidence that relational framing (i) correlates with intellectual skills and abilities required to succeed in the educational arena (ii) can be treated as operant behavior, and, most critically for educational purposes, strengthened via multiple exemplar training; and (iii) has substantial effects on measured intellectual ability when it is trained. The latter work in particular promises great progress in the applied educational realm if RFT procedures were to be applied systematically therein.

This work represents a substantial advance on that reported in the first edited book on RFT. Recent research showing that relational framing can be trained and that such training can have positive effects on cognitive ability is particularly exciting. For example, the study by Cassidy et al. (2011) showing the effect of relational framing on IQ is one of the most promising studies to emerge from the RFT stable thus far in respect of the impact of MET on educationally important outcomes. Nevertheless, of course, there remains much work to be done. As regards the Cassidy et al study, for instance, the effects shown were conducted with a relatively small sample and with less rigorous standards of control than might be desirable. Hence, particularly for purposes of convincing mainstream psychologists of the potential of RFT, it will be

important to conduct much larger scale and more tightly controlled versions of this kind of study.

Future RFT work focused on intellectual development and education should also consider the use of additional dependent measures. Many of the studies listed here have used IQ and standardized language instruments as correlational measures. IQ in particular has been used as a surrogate for other educational outcomes. There is good reason for this since IQ as a measure of intellectual functioning correlates highly with educational outcomes. However, research involving other variables that are of more obviously direct educational relevance than IQ or other standardized measures of ability, including for example, academic or career performance, is needed. This will be particularly important with respect to RFT work on the effect of MET for relational framing. Information on these other outcome variables is less easily obtained than IQ scores and may necessitate longitudinal research. Nevertheless such work is crucial in providing a valid assessment of impact on educational success.

Apart from providing more thorough investigation of the effects of relational framing in general on educational outcomes, there is also more detailed information needed on relational framing itself. Though we have by now amassed a substantial quantity of evidence of the importance of framing in general to language and cognition, research into framing at a more detailed level is still at a relatively early stage in many important respects. For example, there remains as yet little or no investigation of some unquestionably important forms of framing (e.g., spatial and temporal relations, logical relations, hierarchical relations) and as yet limited investigation of some others (e.g., conditional and sequential relations) or how relational frames in general interact with and support each other in the course of development. Building up a detailed picture of the typical development of each of the

major frames and how they interact with each other will be of major educational benefit. In addition, research into relational framing up to this point has focused solely on latency and stimulus control as dependent variables. However, from an RFT point of view, intelligent behavior is characterized by a number of different features including ‘range, speed, flexibility and subtlety of contextual control over relational responding’ (Barnes-Holmes, Barnes-Holmes, Roche, Healy, Lyddy, Cullinan & Hayes, p.161). Hence, while latency and stimulus control are important, additional emphasis on alternative features of intelligent performance including especially flexibility and subtlety of contextual control is needed for a more comprehensive understanding of the parameters characterising relational framing, especially in terms of the relevance of this repertoire for the educational arena.

Finally, there is also much more work needed to adapt RFT training procedures for applied educational domains. There has undoubtedly been good progress already in this respect. Much of the initial work conducted on relational framing involved tapping into the repertoire of individuals already competent in the frames being studied. Over the last few years, however, there has been an increase in research directed at training relational framing in individuals with framing deficits. Nevertheless, the focus of this work has been isolating the influence of multiple exemplar training on the acquisition of relational operants, while minimizing the potential influence of extraneous variables and thereby demonstrating clear behavior-environment relations. The process of conducting basic and analogue research of this type before progressing to applied research has a strong tradition in behavior analysis (Hayes, Blackledge, & Barnes-Holmes, 2001). Ultimately however, the goal of the RFT project is to apply the results of such research to solving problems of social significance (Baer, Wolf, & Risley, 1968) including in the educational arena. There

are beginning to be important inroads made in this respect: the series of studies on mand training in children with autism by Murphy and Barnes-Holmes; research by the fourth author and colleagues that has attempted to apply RFT tactics to teaching socially important relational abilities to developmentally delayed individuals who display deficits; the Cassidy, Roche & Hayes (2011) work on the effect on intellectual ability of training relational framing in children with learning difficulties. This work represents substantial progress, but this is only scratching the surface of the potential of RFT in this respect, and further development of procedures for assessment and training of relational framing is needed. Given the tremendous potential of RFT to facilitate intellectual development and boost achievement of educational outcomes, it behoves those in the RFT community to translate this approach into the applied educational arena as rapidly and effectively as possible.

References

- Baltruschat, L., Hasselhorn, M., Tarbox, J., Dixon, D.R., Najdowski, A.C., Mullins, R.D., & Gould, E. R. (in press). The effects of multiple exemplar training on a working memory task involving sequential responding in children with autism. *The Psychological Record*.
- Baer, D. M., Wolf, M. M., & Risley, T. R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*, 91-97.
- Barnes, D., Hegarty, N., & Smeets, P.M. (1997). Relating equivalence relations to equivalence relations: A relational framing model of complex human functioning. *The Analysis of Verbal Behavior, 14*, 1-27.
- Barnes, D., McCullagh, P., & Keenan, M. (1990). Equivalence class formation in non-hearing impaired children and hearing impaired children. *Analysis of Verbal Behavior, 8*, 1-11.
- Barnes-Holmes, Y., Barnes-Holmes, D., & Cullinan, V. (2001). Education. In S.C. Hayes, D. Barnes-Holmes & B. Roche (Eds.), *Relational frame theory: A post-Skinnerian approach to language and cognition*. New York: Plenum Press.
- Barnes-Holmes, Y., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2001a). Exemplar training and a derived transformation of functions in accordance with symmetry. *The Psychological Record, 51*, 287-308.
- Barnes-Holmes, Y., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2001b). Exemplar training and a derived transformation of functions in accordance with symmetry: II. *The Psychological Record, 51*, 589-604.
- 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, 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, 531-558.
- Barnes-Holmes, D., Staunton, C., Whelan, R., Barnes-Holmes, Y., Commins, S., Walsh, D., Stewart, I., Smeets, P. M., & Dymond, S. (2005). Derived stimulus relations, semantic priming, and event-related potentials: Testing a behavioral theory of semantic networks. *Journal of the Experimental Analysis of Behavior*. 84, 417-434.
- Barnes-Holmes, D., Regan, D., Barnes-Holmes, Y., Commins, S., Walsh, D., Stewart, I., Smeets, P. M., Whelan, R., & Dymond, S. (2005). Relating derived relations as a model of analogical reasoning: Reaction times and event related potentials. *Journal of the Experimental Analysis of Behavior*. 84, 435-452.
- Baron-Cohen, S, Tager-Flusberg, H, & Cohen, D, (eds. 2000). *Understanding other minds: perspectives from developmental cognitive neuroscience*. Oxford University Press.
- Berens, N. M., & Hayes, S. C. (2007). Arbitrarily applicable comparative relations: Experimental evidence for relational operants. *Journal of Applied Behavior Analysis*, 40, 45-71.
- Carpentier, F., Smeets, P. M., & Barnes-Holmes, D. (2002). Matching functionally-same relations: Implications for equivalence-equivalence as a model for analogical reasoning. *The Psychological Record*, 52, 351-312.

- Carpentier, F., Smeets, P. M., Barnes-Holmes, D. (2003). Equivalence-equivalence as a model of analogy: Further analyses. *The Psychological Record*, 53, 349-372.
- Carpentier, F., Smeets, P. M., Barnes-Holmes, D., & Stewart, I. (2004). Matching derived functionally-same relations: Equivalence-equivalence and classical analogies. *The Psychological Record*, 54, 255-273.
- Cassidy, S., Roche, B. & Hayes, S. C. (2011). A relational frame training intervention to raise intelligence quotients: A pilot study. *The Psychological Record*, 61, 173-198.
- 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, 243-257.
- Dickins, D. W., Singh, K. D., Roberts, N., Burns, P., Downes, J. J., Jimmieson, P., & Bentall, R. P. (2001). An fMRI study of stimulus equivalence. *Neuroreport*, 12(2), 405-411.
- Dugdale, N., & Lowe C. F. (2000). Testing for symmetry in the conditional discriminations of language-trained chimpanzees. *Journal of the Experimental Analysis of Behavior*, 73, 5-22.
- Dugdale, N., & Lowe C. F. (1990). Naming and stimulus equivalence. In D. E. Blackman & H. Lejeune (Eds.), *Behaviour analysis in theory and practice: Contributions and controversies* (pp. 115-138). Hove: Lawrence Erlbaum Associates.
- Gomez, S., Lopez, F., Martin, C. B., Barnes-Holmes, Y., & Barnes-Holmes, D. (2007). Exemplar training and derived transformation of functions in accordance with symmetry and equivalence. *The Psychological Record*, 57, 273-294.

- Gore, N. J., Barnes-Holmes, Y., & Murphy, G. (2010). The relationship between intellectual functioning and relational perspective-taking. *International Journal of Psychology and Psychological Therapy, 10(1)*, 1-17.
- Gorham, M., Barnes-Holmes, Y., Barnes-Holmes, D. & Berens, N. (2009). Derived comparative and transitive relations in young children with and without autism. *The Psychological Record, 59*, 221-246.
- Goswami, U. (1991). Analogical reasoning: What develops? A review of research and theory. *Child Development, 62*, 1-22.
- Gould, E., Tarbox, J., O'Hora, D., Noone, S., & Bergstrom, R. (2011). Teaching children with autism a basic component skill of perspective-taking. *Behavioral Interventions, 26*, 50-66.
- Hayes, S. C., Blackledge, J. T., & Barnes-Holmes, D. (2001). Language and cognition: Constructing an alternative approach within the behavioral tradition. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.), *Relational frame theory: A post-Skinnerian account of language and cognition*. New York, NY: Kluwer Academic.
- Hayes, S. C., & Bissett, R. (1998). Derived stimulus relations produce mediated and episodic priming. *The Psychological Record, 48*, 617-630.
- Jäeggli, S. M., Studer-Luethi, B., Buschkuehl, M., Su, Y., Jonides, J. & Perrig, W. J. (2010). The relationship between n-back performance and matrix reasoning - implications for training and transfer. *Intelligence, 38*, 625-635.
- Leader, G., & Barnes-Holmes, D. (2001). Establishing fraction-decimal equivalence using a respondent-type training procedure. *The Psychological Record, 51*, 151-166.

- Luciano, C., Gómez-Becerra, I., & Rodríguez-Valverde, M. (2007). The Role of Multiple-Exemplar Training and Naming in Establishing Derived Equivalence in an Infant. *Journal of Experimental Analysis of Behavior*, 87, 349-365.
- Luo, Q., Perry, C., Peng, D., Jin, Z., Xu, D., Ding, G., & Xu, S. (2003). The neural substrate of analogical reasoning: An fMRI study. *Cognitive Brain Research*, 17, 527-534.
- McHugh, L., Barnes-Holmes, Y., Barnes-Holmes, D. (2004). A relational frame account of the development of complex cognitive phenomena: Perspective-taking, false belief understanding, and deception. *International Journal of Psychology and Psychological Therapy*, 4, 303-323.
- 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.
- Munnely, A., Dymond, S., & Hinton, E. C. (2010). Relational reasoning with derived comparative relations: A novel model of transitive inference. *Behavioral Processes*, 85, 8-17.
- Murphy, C., & Barnes-Holmes, D. (2009a). Establishing derived manding for specific amounts with three children: An attempt at synthesizing Skinner's Verbal Behavior with Relational Frame Theory. *The Psychological Record*, 59, 75-92.
- Murphy, C., & Barnes-Holmes, D. (2009b). Derived more-less relational mands in children diagnosed with autism. *Journal of Applied Behavior Analysis*, 42, 253-268.

- Murphy, C., & Barnes-Holmes, D. (2010). 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: Synthesizing Skinner's Verbal Behavior with relational frame theory. *Journal of Applied Behavior Analysis, 38*, 445-462.
- Ninness, C., Barnes-Holmes, D., Rumph, R., McCuller, G., Ford, A., Payne, R., et al. (2006). Transformation of mathematical and stimulus functions. *Journal of Applied Behavior Analysis, 39*, 299–321.
- Ninness, C., Dixon, M., Barnes-Holmes, D., Rehfeldt, R.A., Rumph, R., McCuller, G., Holland, J., Smith, R., Ninness, S.K., McGinty, J. (2009). Constructing and deriving reciprocal trigonometric relations: A functional analytic approach. *Journal of Applied Behavior Analysis, 42*(2), 191-208.
- Ninness, C., Rumph, R., McCuller, G., Harrison, C., Ford, A. M., & Ninness, S. (2005). A functional analytic approach to computer-interactive mathematics. *Journal of Applied Behavior Analysis, 38*, 1–22.
- Ninness, C., Rumph, R., McCuller, G., Vasquez, E., Harrison, C., Ford, A. M., et al. (2005). A relational frame and artificial neural network approach to computer-interactive mathematics. *The Psychological Record, 51*, 561–570.
- O'Connor, J., Rafferty, A., Barnes-Holmes, D., & Barnes-Holmes, Y. (2009). The role of verbal behavior, stimulus nameability, and familiarity on the equivalence performances of autistic and normally-developing children. *The Psychological Record, 59*, 53-74.

- O'Hora, D., Barnes-Holmes, D., Roche, B., & Smeets, P. M. (2004). Derived relational networks and control by novel instructions: A possible model of generative verbal responding. *The Psychological Record, 54*, 437-460.
- O'Hora, D., Pelaez, D., Barnes-Holmes, D. (2005). Derived relational responding and performance on the verbal subtests of the WAIS III. *The Psychological Record, 55*, 155-175.
- O'Hora, D., Pelaez, M., Barnes-Holmes, D., Rae, G., Robinson, K., & Chaudhary, T. (2008). Temporal relations and intelligence: Correlating relational performance with performance on the WAIS-III. *The Psychological Record, 58*, 569-584.
- O'Toole, C., & Barnes-Holmes, D. (2009). Three chronometric indices of relational responding as predictors of performance on a brief intelligence test: The importance of relational flexibility. *The Psychological Record, 59*, 119-132.
- Persicke, A., Tarbox, J., Ranick, J., & St Clair, M. (2012). Establishing metaphorical reasoning in children with autism. *Research in Autism Spectrum Disorders, 6*, 913-920.
- Persicke, A., Tarbox, J., Ranick, J., & St Clair, M. (in review). Teaching children with autism to detect and respond to sarcasm.
- Pexman, P. M., Rostad, K. R., McMorris, C. A., Climie, E. A., Stowkowy, J., & Glenwright, M. R. (2011). Processing of ironic language in children with high-functioning autism spectrum disorder. *Journal Of Autism And Developmental Disorders, 41*, 1097-1112.
- Rehfeldt, R. A., Dillen, J. E., Ziomek, M. M., & Kowalchuk, R. E. (2007). Assessing relational learning deficits in perspective-taking in children with high functioning autism spectrum disorder. *The Psychological Record, 57*, 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.
- Reilly, T., Whelan, R., & Barnes-Holmes, D. (2005). The effects of training structure on the latency of responses to a five-term linear chain. *The Psychological Record*, *55*, 233-249.
- Ruiz, F. J. & Luciano, C. (2011). Cross-domain analogies as relating derived relations among two separate relational networks. *Journal of Experimental Analysis of Behavior* *95*(3), 369-385.
- Schusterman, R.J. & Kastak, D. (1993). A California sea lion (*Zalophus californianus*) is capable of forming equivalence relations. *Psychological Record*, *43*, 823-839.
- Sidman, M. (1971). Reading and auditory-visual equivalences. *Journal of Speech and Hearing Research* *14*, 5-13.
- Sidman, M., Rauzin, R., Lazar, R., Cunningham, S., Tailby, W. & Carrigan, P. (1982). A search for symmetry in the conditional discriminations of rhesus monkeys, baboons and children. *Journal of Experimental Analysis of Behavior* *37*(1), 23-44.
- Skinner, B. F. (1957). *Verbal Behavior*. Acton, MA: Copley Publishing Group.
- Sternberg, R. J., & Rifkin, B. (1979). The development of analogical reasoning processes. *Journal of Experimental Child Psychology*, *27*, 195–232.
- Tarbox, J., Zuckerman, C. K., Bishop, M. R., Olive, M. L., & O’Hora, D. P. (2011). Rule-governed behavior: Teaching a preliminary repertoire of rule-following to children with autism. *The Analysis of Verbal Behavior*, *27*, 125-139.

- Villatte, M., Monestès, J. L., McHugh, L., Freixa i Baqué, E., & Loas, G. (2010a).
Assessing perspective taking in schizophrenia using Relational Frame Theory.
The Psychological Record, *60*, 413-424.
- Villatte, M., Monestès, J. L., McHugh, L., Freixa i Baqué, E., & Loas, G. (2010b).
Adopting the perspective of another in belief attribution: Contribution of
Relational Frame Theory to the understanding of impairments in
schizophrenia. *Journal of Behavior Therapy and Experimental Psychiatry*, *41*,
125-134.
- Weil, T. M., Hayes, S. C., & Capurro, P. (2011). Establishing a deictic relational
repertoire in young children. *The Psychological Record*, *61*, 371-390.
- Wechsler, D. (1991). *The Wechsler intelligence scale for children, 3rd edition*. San
Antonio, TX: The Psychological Corporation.
- Wechsler, D. (2004). *The Wechsler intelligence scale for children, 4th edition*.
London: Pearson Assessment.