International Journal of Psychology and Psychological Therapy 2009, 9, 1, 1-17

Relational Flexibility and Human Intelligence: Extending the remit of Skinner's *Verbal Behavior*

Catriona O'Toole, Dermot Barnes-Holmes, Carol Murphy, Jennifer O'Connor, and Yvonne Barnes-Holmes

National University of Ireland, Maynooth, Ireland

Abstract

The current article will discuss recent research encompassing the relevance of derived relational responding in intelligence, and the establishment of procedures to target this type of flexibility in derived relational responding in practical learning situations. The chapter will review research findings that indicate correlations between speed in flexible relational responding and higher scores on IQ tests. Relevant to flexibility in relational responding, research has demonstrated that children with autism showed poorer flexibility in relational responding than typically-developing peers, and procedures to remediate this type of "rigid" responding are described. Research on derived manding also has practical implications for incorporating derived relational responding into a mand training program to facilitate a "generative" or flexible component.
Key words: Verbal behavior, derived relational responding, intelligence, flexibility, mand.

Resumen

El presente artículo discute investigaciones recientes centradas en la relevancia del aprendizaje relacional derivado para la inteligencia, y en el establecimiento de procedimientos orientados a promover esta flexibilidad del aprendizaje relacional derivado en situaciones prácticas de aprendizaje. El artículo revisa hallazgos de investigación indicativos de la correlación entre la rapidez en el comportamiento relacional flexible y las puntuaciones altas en tests de CI. Con respecto a la flexibilidad del comportamiento relacional, la investigación ha demostrado que los niños con autismo muestran un comportamiento relacional menos flexible que el de los niños que siguen un patrón típico de desarrollo. Se describen aquí algunos procedimientos para corregir este tipo de comportamiento "rígido". La investigación sobre mandos derivados también tiene implicaciones prácticas para incorporar el comportamiento relacional derivado a un programa de entrenamiento de los mandos para facilitar un componente "generativo" o flexible.
Palabras clave: conducta verbal, comportamiento relacional derivado, inteligencia, flexibilidad, mando.

In *Verbal Behavior* (1957) Skinner laid out a theory for the functional analysis of human language. The book was severely criticized, most notably by Chomsky (1959), and this served to undermine not only Skinners work, but, it has been argued, the field of behavior analysis in general. Yet *Verbal Behavior* has also been hailed as a *great*

* Correspondence concerning this article should be addressed to the first author: Catriona O'Toole, National University of Ireland, Maynooth, Co. Kildare, Ireland. Email: catriona.a.otoole@nuim.ie

book (MacCorquodale, 1969). It has been credited with instigating important advances in the treatment of language disorders (e.g., Sundberg & Michael, 2001), and with engendering additional research in conceptual as well as applied domains (e.g., Palmer, 2006). Indeed, a recent citation analysis highlighted that it continues to make an important contribution to the psychological literature (Dymond, O'Hora, Whelan, & O'Donovan, 2006).

While many of the studies spawned by *Verbal Behavior* remain true to Skinner's original analysis, it is of course natural and fitting that a theory, half a century old, should be updated with more recent research findings. In fact, most of the original criticisms leveled against *Verbal Behavior* have been addressed by doing just that. Skinner's treatment of verbal behavior focused on language learning that occurred through direct histories of reinforcement. In contrast, modern findings based on the phenomenon of stimulus equivalence (see Sidman, 1994, for a review), and the concepts of Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) have emphasized the inherently derived or emergent nature of human language. In this article we will first outline the basic features of RFT and then highlight the utility of integrating this approach with Skinner's analysis. The remainder of the article will focus on relational flexibility, which we will argue is central to the development of increasingly complex cognitive performances. New assessment and training procedures, which may facilitate the development of relational flexibility in applied settings, will also be outlined. The aim of the current article is to provide a rationale and framework around which current researchers can propagate and extend this important research agenda instigated by Skinner all those years ago.

Relational Frame Theory

Relational Frame Theory (RFT: Hayes *et al.*, 2001) recognizes that a fundamental aspect of human cognition is the ability to identify relations between and among stimuli and events. While many species are capable of responding relationally (e.g. Reese, 1968), humans seem to be particularly proficient at identifying relations that extend beyond the formal properties of the relata. That is, humans can respond to objects and events, even when the relation between them is defined not by their physical properties, but by arbitrary contextual cues (i.e. cues that may be applied on the basis of social whim or convention). This type of responding is called *arbitrarily applicable relational responding* (AARR).

Since words are arbitrary forms, learning to name objects and events serves as a useful example of this type of responding. When interacting with a young child, a caregiver will often utter the name of an object and then reinforce any orienting response toward that object. When this occurs the caregiver is training an arbitrary relation of similarity between the word and the object. For instance, upon hearing the word *apple* a child will be praised for pointing to, looking at, or selecting an actual apple. On other occasions, however, the caregiver may present the actual apple and then model and reinforce the appropriate response (i.e., the word *apple*). In the early stages of language development a number of these name-object and object-name exemplars will be explicitly trained. Gradually, however, the child no longer needs explicit reinforcement for each naming response. After a sufficient number of exemplars the child learns to abstract out the specific contextual cues as discriminative for the derived naming response and can therefore respond appropriately in novel instances. Thus, when the child is presented with an unfamiliar object and told, for example, “this is, a guava” (i.e., when an object-name relation is trained) he/she will spontaneously reverse this relation without further training, by providing a name-object relational response (see Luciano, Gomez Becerra, & Rodriguez Valverde, 2007, for relevant empirical evidence).

Researchers have examined the emergence of relational responses, in more abstract terms, as conditional discriminations consisting of sample and comparison stimuli. A typical procedure for examining these relations in laboratory settings might involve reinforcing the selection of comparison stimulus B1, and not B2, in the presence of sample A1, and for selecting C1, and not C2, in the presence of sample B1. When these conditional discriminations are established most verbally-able humans will readily derive additional relations between the stimuli in the absence of further training. Thus a verbally-able human will select A1 in the presence of B1, and B1 in the presence of C1. They will also select C1 in the presence of A1, and A1 in the presence of C1. According to Sidman and Tailby (1982) these novel emergent relations are referred to respectively as symmetry (B-A), transitivity (A-C), and equivalence (C-A). In RFT nomenclature these relations are referred as mutually entailed, when they involve a pair of stimuli and combinatorially entailed, when they involve more than two stimuli (Hayes *et al.*, 2001).

The ease with which normally developing children spontaneously demonstrate emergent relational performances is an important feature of AARR. Even very young children show evidence of mutual and combinatorial entailment (Lipkens, Hayes, & Hayes, 1993) but it occurs with much greater difficulty, or not at all, in non-verbal participants (e.g., Barnes, McCullagh, & Keenan, 1990; Devany, Hayes, & Nelson, 1986) and non-humans species (Dugdale & Lowe, 2000; Sidman & Tailby, 1982). A further key feature of AARR is what’s known as the *transformation of functions* (Barnes-Holmes, Hayes, Dymond, & O’Hora, 2001). When a child is taught that the word *biscuit* refers to an actual biscuit, he/she may respond with excitement upon hearing the word. If the child then learns that *biscuit* and *cookie* mean the same thing (i.e., participate in an equivalence relation), then the child may become excited upon hearing the word *cookie*, even when it has never been directly paired with an actual cookie/biscuit. Thus, given the child’s prior history of responding to the word *biscuit*, some of the functions of that word (i.e., excitement) transfer to the word *cookie* based on an equivalence relation.

There is now considerable research to suggest that stimulus equivalence may be a generalized operant response class that is pervasive in human language (see Barnes, 1994; Barnes-Holmes, Barnes-Holmes, Smeets, Cullinan, & Leader, 2004 for reviews). However, besides equivalence, there are many other relations that form an inherent part of human verbal or cognitive activity. Humans have a unique ability to carry out many complex tasks, such as, solving mathematical problems, learning from analogies, understanding a sequence of events, and planning for the future. Proficiency in each of these areas also depends on the ability to relate arbitrary stimuli, but it requires responding to relations, that extend beyond those of equivalence (Hayes *et al.*, 2001). The term *relational frame* has been coined by RFT to highlight particular patterns of relational responding and a number of relational frames have been subjected to empirical analysis. These include frames of similarity, distinction, opposition (Steele & Hayes, 1991), comparison (Dymond & Barnes, 1995) and hierarchy (Griffee & Dougher, 2002), as well as temporal (O'Hora, Barnes-Holmes, Roche, & Smeets, 2004), and deictic relations (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004).

Skinner's Verbal Behavior and RFT

As noted above, *Verbal Behavior* has had particular relevance to the treatment of language and other developmental disorders. Thus while critics may point to the book's failure to influence language theories in mainstream psychology (see Bailey & Wallender, 1999), there can be little doubt about its impact and utility in applied settings. The formulations imparted by Skinner provided the basis for educational programs and teaching procedures that have proven very effective particularly in the treatment of autistic spectrum disorders (e.g., Sundberg & Parington, 1998; Sundberg & Michael, 2001; Lovass, 1987; McEachin, Smith, & Lovass, 1993).

On balance, some authors have argued that while this influence in the area of learning disabilities is admirable, it represents only the beginning of what a behavioral theory of language should seek to explain (Dixon, Small, & Rossales, 2007). Indeed, perhaps one of the main reasons for the limited impact of *Verbal Behavior* is that it did not fully account for the generativity, novelty, and sheer power of human language (e.g. Chomsky, 1959; Hayes *et al.*, 2001). It should be recognized, however, that Skinner was well aware of the generative nature of language. For example, he acknowledged that some mands (requests) cannot be accounted for on the basis of a direct history of reinforcement, and suggested that "the speaker appears to create new mands on the analogy of old ones" (Skinner, 1957, p.48). Likewise, in the case of tacts (naming responses) he refers to their "generic extension" as when "a speaker calls a new kind of chair a chair" (p.91). Indeed, in discussing autoclitics (grammatical tags), Skinner touched on the generative nature of these operants. Consider for example the following passage in which Skinner suggested that:

> Having learnt the response "the boy's gun, the boy's shoe, and the boy's hat, we may suppose that the partial frame the boy's ________ is available for recombination with other responses. The first time the boy acquires a bicycle, the speaker can compose a new unit the boy's bicycle…. The relational aspects of the situation strengthens the frame, and specific features of the situation strengthen the response fitted into it" (p. 336).

Furthermore, Skinner also provided an example of symmetry relations in natural language when he wrote that upon hearing the sentence, *an amphora is a Greek vase* *with two handles*, a listener might "(1) say, *amphora*, when asked, *what is a Greek vase with two handles called?*, and (2) say, *a Greek vase having two handles* when asked, *what is an amphora?*, and (3) may point appropriately when asked, *which of these is an amphora?*" He goes on to say that "these are not the results which occur spontaneously in the naive speaker but rather as the product of a long history of verbal conditioning" (p. 360). Nevertheless, while there are clear references to generativity in Skinner's work, few would argue that it is a dominant feature of it. Ultimately, therefore, it is the direct learning of language, rather than derived or emergent performances that is central to his analysis.

One consequence of this focus on direct learning is that it necessitates training a vast array of content. In applied settings this means providing reinforcement for correct responding across an extensive number of training trials. A side effect of this approach is that as correct responding is reinforced, behavioral variability decreases, and stereotypy or rigidity may result (e.g., Vogel & Annau, 1973). Indeed, the possibility that this type of approach is responsible for reinforcing rigid and robotic-like behavior is one of the most common criticisms leveled against applied behavior analysis (see, Lovass & Wright, 2006). This criticism is undoubtedly excessive, especially when weighted against the substantial benefits that behavior analysis has provided. However, the issue of sustained reinforcement for standard, correct responding does warrant further consideration in applied settings.

A focus on derived relations may offer one possible way forward. Relational Frame Theory emphasizes that generative and derived performances are central and defining features of human language and cognition. Thus, in applied settings it should be possible to train a specific array of content and, in appropriate contexts, for additional performances to emerge without the need for further explicit training and reinforcement. Indeed this basic assumption has been supported across a growing number of recent studies involving both normally developing (e.g., Barnes-Holmes, Barnes-Holmes, Roche, & Smeets, 2001a, 2001b) and learning disabled populations (e.g., Murphy, Barnes-Holmes, & Barnes-Holmes, 2005; Rehfeldt & Root, 2005; Rosales & Rehfeldt, 2007). Furthermore, RFT places particular emphasis on the process of learning rather than on content per se. According to RFT it may be particularly advantageous to focus on training a core set of overarching or higher-order operant response classes (i.e., generic cognitive skills). These core processes could then be arbitrarily applied to any stimulus content. By focusing on derived performances and cognitive processes, defined in functional-analytic terms, it may be possible to circumvent the problems associated with directly training and reinforcing a vast amount of content.

The contrast between Skinnerian and RFT approaches does not necessarily imply that they are incompatible. Indeed, Barnes-Holmes, Barnes-Holmes and Cullinan (2000) have provided a systematic RFT interpretation for each of Skinner's verbal operants, thereby demonstrating that, conceptually, a synthesis between the two approaches is possible. More recently, much empirical work has unfolded which is highlighting the practical utility of synthesizing the two approaches in applied settings. We will return to this research toward the end of the article. First, it is necessary to outline a further key process emphasized by RFT, and one that may go some way toward addressing the issue of reinforced rigidity in applied settings. Specifically, we will now turn to the issue of relational flexibility.

Relational Flexibility: Conceptual issues

From an RFT perspective derived relational responding is considered a form of generalized operant class (see Barnes-Holmes & Barnes-Holmes, 2000; Healy, Barnes-Holmes, & Smeets, 2000). A key property of such classes is that they can be shaped or altered when environmental contingencies are manipulated and they are therefore inherently flexible. Evidence for the operant and flexible nature of relational responding is provided by studies which demonstrate that derived relational performances are sensitive to contextual and consequential control. There are a number of studies that have demonstrated that contextual cues can bring about different patterns of derived relational performances (e.g., Dymond & Barnes, 1994; Roche, Barnes-Holmes, Smeets, Barnes-Holmes, & McGeady, 2000). Likewise, derived relational performances also appear sensitive to consequential control. For instance, Wilson and Hayes (1996) showed that once derived performances are established, they can be disrupted, and then readily reestablished by the differential feedback provided to participants. Taken together these studies highlight, therefore, that derived relational responding is functionally similar to other operant behaviors, and as such it possesses the property of flexibility.

Interestingly, it has been argued that flexibility in relational responding, particularly as it comes under increasingly subtle forms of contextual control, may underpin abilities such as creativity, problem-solving, and intelligence more generally (Hayes, 1994; Barnes, Hagerty, & Smeets, 1997; Healy, Barnes-Holmes, & Smeets, 2000). Indeed, within mainstream cognitive psychology the ability to adopt flexible response strategies has long been regarded as an important feature of human intelligence (e.g., Cattell, 1971; Kyllonen, Lohman, & Woltz, 1984).

If flexibility is indeed a core feature of human intelligence, then it follows that rigidity, the antithesis of flexibility, is likely to be detrimental to intelligence. Indeed, there are numerous studies that demonstrate the deleterious effects of cognitive rigidity across many different populations (e.g. autism, Turner 1999; Attention Deficit/Hyperactivity Disorder, Lovecky, 2004; schizophrenia, Pishkin & Williams, 1997; and normal adults, Wulfert, Greenway, Frakas, Hayes & Dougher, 1994). The issue of rigidity may be particularly problematic in applied settings considering that behavioral interventions have predominantly been used in the treatment of those with autistic spectrum disorders. A tendency toward rigid, stereotypic behavior is of course a defining feature of autism (DSM-IV-TR, 2000). Furthermore, given that sustained reinforcement for particular types of responding can also result in less variable repertoires (as highlighted above), combating rigidity is perhaps an issue that might be placed at the forefront of the behavior analyst’s agenda.

Indeed, many researchers and behavior analysts have recognized that perseverative, stereotypic, and rigid behavioral repertoires can interfere with learning, and have successfully applied behavioral techniques to counter these effects. For instance, Rehfeldt and Chambers (2003) reduced verbal perseverations with an intervention consisting of differential reinforcement of appropriate verbal responses and extinction of perseverative responding. Ahearn, Clark, McDonald, and Chung (2007) reduced stereotypic vocalizations using response interruption and redirection. Others have shown that more varied responding can result when reinforcement is made contingent upon producing a variety of responses (Miller & Neuringer, 2000) and when reinforcement is provided for responses that differ from a specified number of previous responses (Lee, McComas, Jawlor, 2002).

As well as working to counter the effects of behavioral rigidity, it would also seem particularly important to introduce procedures that might prevent rigidity from taking hold in the first place. While there may be many diverse factors that make it likely that an individual will develop rigid response patterns, it is a core assumption of the current article that promoting relational flexibility may be extremely important in terms of avoiding rigidity. Indeed, if flexibility is a core component of intelligence, then incorporating flexibility may not only avoid the deleterious effects of rigidity, but is also likely to foster increasingly adaptive and intelligent behaviors. Thus, in the next section of the current article, we will outline a recent research program highlighting the importance of relational flexibility. Subsequently, we will examine methodologies and procedures that may have utility in training flexibility in applied settings.

Relational Flexibility: Empirical and applied issues

Despite the well established findings in mainstream psychology of the importance of flexibility as a component in intelligence, there has been a dearth of research on this topic in the field of behavior analysis. Recently, however, an RFT-based research program has been instigated, which aims to investigate this issue as well as to provide possible methodologies and procedures for training relational flexibility in applied settings. In order to test the basic idea that relational flexibility and intelligence are indeed related, a preliminary study was undertaken by O'Toole and Barnes-Holmes (in press). The study showed that university students who obtained higher scores on a brief intelligence test demonstrated a greater degree of relational flexibility, on before/after and similar/different relational tasks, relative to those with average scores. This research is also noteworthy because it employed a new methodology for presenting the relational tasks, namely the Implicit Relational Assessment Procedure (IRAP Barnes-Holmes, Barnes-Holmes, Power, Hayden, Milne, & Stewart, 2006; McKenna, Barnes-Holmes, Barnes-Holmes, & Stewart, 2007; Barnes-Holmes, Hayden, Barnes-Holmes, & Stewart, in press). The preliminary findings from the O'Toole and Barnes-Holmes study suggest that the IRAP may be a useful tool for assessing and training relational flexibility. It is therefore worth describing the IRAP in more detail.

The Implicit Relational Assessment Procedure (IRAP)

The IRAP is a computer-based task which was developed, in part, to assess socalled implicit relations, but also provides measures of relational responding and relational flexibility. The IRAP requires participants to respond accurately and rapidly to a series of relational tasks. In some blocks of tasks, participants are asked to respond in a way that is consistent with previously learned relations (is a Shoe similar to a Sandal? = True), and in other blocks responding in an inconsistent pattern is required (is a Shoe similar to a Sandal?= False). To some extent the IRAP can be tailored to the individual needs of the researcher, but it typically involves presenting 24 or 32 trials across a series of practice and test blocks. Each IRAP trial involves presenting one of two sample stimuli at the top of the computer screen, target stimuli in the centre of the screen, and two response options at the bottom left and right hand corners. The various combinations of sample stimuli with target stimuli serve to generate four different trial-types. For example, in the O'Toole and Barnes-Holmes study, one trial-type was generated by presenting Sample 1 with congruent targets (e.g. *Similar* with *Shoe Sandal*); another by presenting *Sample 2* with congruent targets (e.g. *Different* with *Shoe Apple*); a third by presenting Sample 1 with *incongruent* targets (e.g. Similar with Shoe Apple); and a fourth by presenting Sample 2 with *incongruent* targets (e.g. *Different* with *Shoe Sandal*). Figure 1 illustrates an example of each of these trial-types as they would appear on the computer screen.

The general assumption underlying the IRAP is that participants will respond more rapidly on consistent than on inconsistent trials, and this prediction has been supported across numerous studies (e.g., Barnes-Holmes *et al.*, 2006). Critically, however, performance on the inconsistent trials is unlikely to be a well practiced or firmly established skill (individuals rarely practice incorrect responding for protracted periods of time). Consequently, response speed on these trials may provide a possibly useful measure of relational or cognitive flexibility. In other words, the faster an individual can produce responses that contradict previously well-established verbal relations (by the wider community), the more flexible the behavior.

However, in addition to the response latency measures that are obtained across consistent and inconsistent trials, it is also useful to calculate a difference-score by subtracting latencies on consistent trials from those on inconsistent trials. This difference-score provides an additional and perhaps "purer" measure of relational flexibility in that extraneous variables, such as the length of time required to read the stimuli on the screen, are now removed. Furthermore, the IRAP is designed so that the blocks of trials alternate between those that require consistent responses and those that require inconsistent responses. Thus, the requirement for relational flexibility is maintained throughout the IRAP procedure because the individual has to shift continually between correct and incorrect responding. The difference-score is seen as providing a measure of relational flexibility in that the smaller the difference, the more flexible the relational responding. In other words, the less time it takes a participant to produce a "weak" pattern of responding relative to a "strong" pattern, the more flexible the behavior.

In the O'Toole and Barnes-Holmes (in press) study, two IRAPs were presented; one assessed similar/different relations and the other assessed before/after relations. Results showed that the two measures of relational flexibility (i.e., the inconsistent response latencies and the difference-score) correlated significantly with the intelligence measures across both relational tasks, whereas the consistent response latencies did so to a much lesser degree. In addition, the correlations showed that the difference-score loaded more heavily on the Verbal than on the Matrices subtests of the IQ measure (see

Similar/Different Relational Task Presented using the IRAP

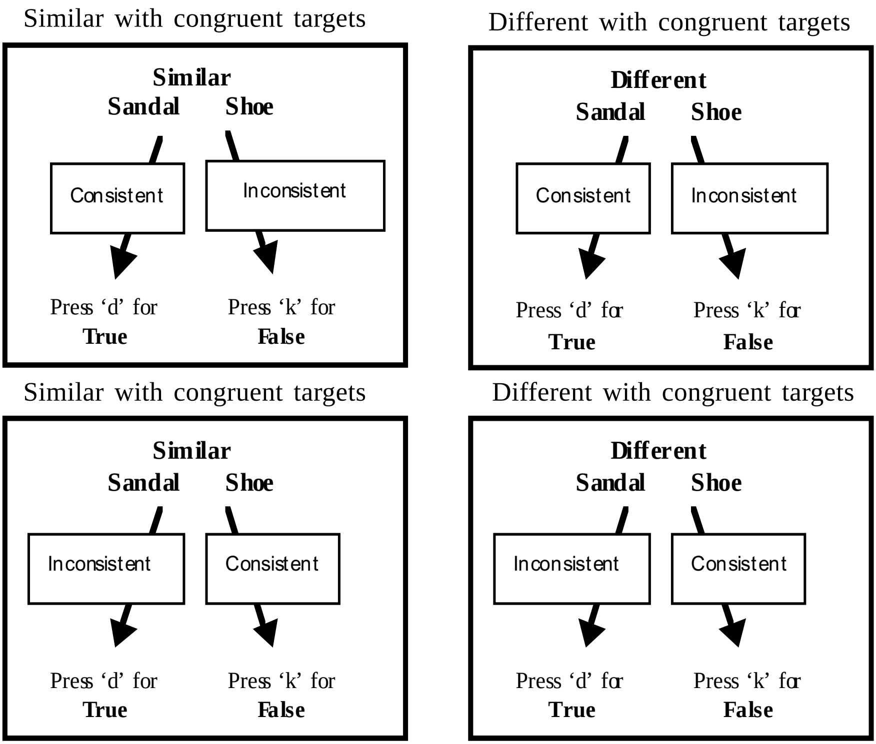

Figure 1. Examples of four trial-types on the similar/different IRAP employed by O'Toole & Barnes-Holmes (in press). Sample stimuli, target words, and response options were presented simultaneously on the screen. Note that the superimposed arrows and text boxes, used here to illustrate consistent and inconsistent responses, did not appear on the screen during the IRAP.

O'Hora, Pelaez, & Barnes-Holmes, 2005; O'Hora, Peláez, Barnes-Holmes, Rae, Robinson, & Chaudhary, in press, for related findings).

Training Relational Flexibility

The research outlined above suggests that relational flexibility may be an important functional-analytic component of intelligence, and thus it may be wise to build upon the forgoing findings and attempt to incorporate flexibility into applied educational settings. Indeed, recently a series of studies have begun to do just that. We will now provide an overview of these studies as well as outlining a potentially useful direction for future research.

Flexible Symmetry and Asymmetry Training

One of the first studies to focus on targeting relational flexibility was that conducted by O'Connor (2004; see also O'Toole, Murphy, Barnes-Holmes, & O'Connor, in press, for a detailed description the training protocol employed). The study essentially involved targeting relational flexibility by using contextual cues to govern standard versus nonstandard responding. Thus, in one experiment, O'Connor (2004) examined the extent to which, both normally developing children and those with a diagnosis of autism (aged 6-9 years), could provide a symmetrical (standard) versus an asymmetrical (nonstandard) response depending on the presence of contextual cues. Symmetry and asymmetry involve the reversal of a trained relation. In abstract terms, consider a learner who is trained to select stimulus B1 in the presence of A1 and B2 in the presence of A2 (i.e., A1-B1 and A2-B2 are directly trained). When testing the derivation of the target symmetry relations, based on the initial conditional discrimination training, the learner is then presented with B1 or B2 and asked to select either A1 or A2 as appropriate. In this case, selecting A1 would be the correct symmetrical response in the presence of B1, and A2 would be correct in the presence of B2. The opposite selections would be asymmetrical (B1-A2 and B2-A1). Thus, the asymmetrical response involves selecting the stimulus that is *not* the same as that which was trained. In effect, on the asymmetrical trials the learner is being asked to provide the "wrong" answer.

In O'Connor's (2004) study the children were required to learn, through a trial and error process, that in the presence of one cue they should emit the symmetrical response and in the presence of another cue they should emit the asymmetrical response. Further experimental phases were included to determine whether the contextual cues generalized to other novel sets of stimuli. The results showed that all of the normally developing children proceeded rapidly and competently through the training and testing phases. In contrast, most of the children with autism had problems producing the generalized contextually controlled performances and many demonstrated difficulties early on in the symmetry and asymmetry training. Thus, the results indicated that, as a group, the children with autism demonstrated a degree of rigidity that was not observed in the normally developing children.

The next phase of O'Connor's (2004) study therefore involved incorporating flexibility training for those children who had difficulty producing the asymmetrical response pattern. The flexibility training incorporated a number of phases, which children were exposed to until they reached a pre-specified criterion on the symmetry and asymmetry trials. The first phase, for instance, involved explicitly instructing the child to provide a "right" or "wrong" naming response. Specifically, on each trial the instructor pointed to one of five pictures and provided the child with one of two antecedents: *"What is it? Give me the right answer"* or *"What is it? Give me the wrong answer"*. A correct response involved naming the picture correctly or incorrectly, depending on the instruction given. In subsequent phases, contextual cues were introduced and these gradually came to control correct versus incorrect responding, as the explicit instructions were phased out. Following this intervention, all of the children reached criterion on the contextually controlled symmetry and asymmetry trials. As a whole, therefore, the intervention constituted a first important step in the establishment of flexible relational repertoires, which for reasons outlined earlier, is likely to be critical in terms of promoting intelligent and creative behaviors. Importantly, the intervention also highlighted that flexible response repertoires can be taught, and that behavioral rigidity or stereotypy need not be an immutable characteristic of autism.

Flexible Mand Training

Another series of studies that have attempted to incorporate flexibility have focused on Skinner's mand operant and integrated it with the RFT concept of derived transformation of function. The rationale for this series of studies was that it should be possible to establish increasingly complex and flexible manding repertoires without having to train each mand individually. In effect, after establishing a single mand for a particular reinforcer, it may be possible to transfer that function to novel response forms via conditional discrimination training. Subsequently, a child may employ these novel forms as mands without a direct training history for doing so.

In the first study of the series (Murphy, Barnes-Holmes & Barnes-Holmes, 2005) a 'boardgame' format required that children mand for two types of tokens using specific mand cards (arbitrary symbols, A1 and A2). A match-to-sample procedure was then used to train interrelated conditional discriminations between each of the two mand cards and four more cards with different arbitrary symbols (A1-B1-C1, A2-B2-C2). Subsequent to successful conditional discrimination training, the children were exposed to a test procedure to determine if the children would mand correctly with C1 and C2 without explicit training. Results showed that all seven children with diagnoses of autism successfully demonstrated what Murphy *et al.* (2005) described as a derived transfer of mand functions (derived mands for "more" tokens).

Murphy and Barnes-Holmes (2006) sought to extend the work of Murphy et al. (2005) with four children (aged 7-8) diagnosed with autism, and this second study attempted to establish two different classes of derived mand, one class functioning as a request for "more" and the other as a request for "less." The study again used a 'boardgame' format that required participants to mand for the delivery or removal of tokens in order to retain a panel of six tokens on the board. All four participants successfully demonstrated that they could mand with C1 for "more" tokens and mand with C2 for "less" tokens (based on a transfer from A1 and A2, respectively) without being directly trained to do so.

Subsequent studies sought to establish five specific derived relational mands with a total of three children with no diagnosed learning disorders (Murphy & Barnes-Holmes, in press a) and with three adolescents with diagnosed autism (Murphy & Barnes-Holmes, in press b). These participants showed derived manding for -2, -1, 0, +1, and +2 tokens, by correctly presenting five mand cards with different symbols in the absence of explicit training. Complexity was again increased in a later study (Murphy & Barnes-Holmes, in press c) and participants with and without diagnosed learning disorders showed derived manding for five specific amounts of tokens based on a derived *transformation* of function. Derived manding in the previous studies was based on a *transfer* of functions through equivalence relations, thus the mands were essentially synonymous. Derived manding based on a transformation of function meant that the comparative values of the mands were derived in relation to each other, rather than through a transfer of functions based on equivalence relations (see Murphy & Barnes-Holmes, in press c, for a detailed explanation of derived manding based on transformation of function).

Another interesting feature in the derived mand research is that exemplar training was used with some students who failed to show derived manding, and this intervention appeared to facilitate derived manding for these participants (Murphy et al., 2005; Murphy & Barnes-Holmes, in press c; Murphy & Barnes-Holmes, under submission). When a participant failed to show derived manding during test procedures, he or she subsequently underwent exemplar training that involved explicit training of the target derived mands, and then underwent the entire training and test procedure again, using novel stimuli. If the participant failed the second test for derived mands, exemplar training with the novel stimuli was commenced, followed by a repeated training and test procedure with yet another set of stimuli. The process continued with different sets of novel stimuli until the participant showed derived manding. Findings indicated that multiple exemplars of transfer facilitated a demonstration of derived transfer for these participants. Future research will need to investigate more fully the role of multiple exemplar training in establishing flexible and derived manding.

Possible Directions for Future Research

The studies outlined above build upon existing technologies by providing a practical framework for establishing generative and flexible relational repertoires in applied settings. Another avenue towards incorporating flexible relational responding is to employ a variety of IRAP protocols to tap into a range of relational frames. Thus, given that the measures of relational flexibility on the IRAP produced significant correlations with intelligence, a logical next step for future research is to use the IRAP as a tool to target relational flexibility. Perhaps repeated exposures to such IRAPs could facilitate the development of relational flexibility and in so doing promote increasingly adaptive and intelligent behaviors.

Indeed, it seems likely that the IRAP could be used to train intelligent behaviors because as well as tapping into relational responding and flexibility, the IRAP also appears to tap into a range of other areas considered to be important in intelligence, such as processing speed, working memory, and freedom from distraction. Thus, it is possible that the IRAP could be used as a type of “brain training” procedure. A range of cognitive abilities tests could be administered both before and after the IRAP intervention to assess whether the training has any generalisable effect on standard measures of cognitive ability.

The basic idea behind such training is that is that the IRAP could be used to target a range of increasingly complex relational performances. Initially, more basic relational frames could be incorporated into the IRAP, such as the similar/different and before/after relations used in the O’Toole and Barnes-Holmes (in press) study. As fluency and flexibility is built up on these frames, the relations targeted could gradually become more complex. For instance, frames of hierarchy and comparison could be introduced. In addition, it would also be possible to introduce relations involving basic arithmetic, numerical sequences, as well as relations between relations (i.e. analogies).

Although the participants who took part in the O'Toole and Barnes-Holmes study were normal adults, preliminary and unpublished data from the Maynooth Laboratory suggests that other populations can successfully complete the type of IRAP protocols mentioned. For instance, a number of adults with dyslexia, and a child, aged 10, with a mild learning difficulty have completed these IRAP tasks. Also of relevance is a study by Scanlon (2007) who used the IRAP to assess self-esteem in children (aged 8-14 years), who presented, both with and without, a diagnosis of attention deficit hyperactivity disorder (ADHD). In this study, the IRAP tasks were presented as a type of "computer game" and all of the children, including those with ADHD, successfully completed the protocols.

Thus, the IRAP seems to offer a promising methodology for training relational flexibility. However, empirical analysis is required before the utility of using the IRAP in this way can be determined. Indeed there are numerous questions that need to be addressed, in terms of how to use the IRAP in the most efficient manner. For instance, how many relational IRAPs would typically be required before observable effects are recorded on a cognitive abilities test? Should relational frames be targeted in a particular sequence? What criteria (in terms of percentage correct and response latency) should be reached on basic relational frames before progressing to more complex relations? There are currently a series of studies being planned in the Maynooth Laboratory which aim to investigate these and other issues. It is hoped that these studies will increase our ability to improve verbal and cognitive performance across both typically developing and learning disabled populations.

Conclusion

The current article has highlighted the importance of emphasizing the inherently relational and derived nature of human language and cognition. We have argued that relational flexibility is a core component of higher cognition and outlined the growing number of procedures and methodologies that are available to researchers as training and assessment tools. In outlining these procedures we have drawn on concepts that may seem far removed from those originally outlined by Skinner (1957). However, the RFT concepts highlighted throughout the article (derived relational responding, relational flexibility etc.) draw on well established behavioral principles, many of which were first highlighted by Skinner himself. Indeed, one of the major strengths of Skinner's approach to verbal behavior is that he focused on the operant nature of language. In this respect the RFT approach is entirely consistent with the core conceptual analysis of human language that Skinner first provided. Some of the recent research connects directly with Skinner's work by simply extending the concept of the mand to include derived mands. Other features of the work seem more distantly related, such as the IRAP studies, but these nonetheless involve conceptualizing verbal relations as inherently operant in nature. Thus, by expanding on Skinner's original conceptualization of language it is hoped that the research agenda outlined in the current article will serve to extend the remit of *Verbal Behavior* in targeting increasingly flexible and intelligent behavioral repertoires.

References

Ahearn WH, Clark KM, MacDonald RPF, & Chung B (2007). Assessing and treating vocal stereotypy in children with autism. *Journal of Applied Behavior Analysis*, *40*, 263-275.

Bailey JS & Wallander RJ (1999). Verbal Behavior. In BA Thyer (Ed.), *The Philosophical legacy of behaviorism* (pp. 117-152). Dordrecht: Kluwer Academic.

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

Barnes D, Hegarty N, & Smeets PM (1997). Relating equivalence relations toequivalence relations: A relational framing model of complex human functioning. *The Analysis of Verbal Behavior, 14,* 1-27.

Barnes D, McCullagh PD, & Keenan M (1990). Equivalence class formation in nonhearing impaired children and hearing impaired children. *Analysis of Verbal Behavior, 8,* 1-11.

Barnes-Holmes D, & Barnes-Holmes Y (2000). Explaining complex behavior: Two perspectives on the concept of generalized operant classes. *The Psychological Record, 50*, 251-265.

Barnes-Holmes D, Barnes-Holmes Y, & Cullinan V (2000). Relational frame theory and Skinner's Verbal Behavior: A possible synthesis. *The Behavior Analyst*, *23*, 69-84.

Barnes-Holmes D, Barnes-Holmes Y, Power P, Hayden E, Milne R, and Stewert I (2006). Do you really know what you believe? Developing the Implicit Relational Assessment Procedure as an indirect measure of implicit beliefs. *The Irish Psychologist, 32*, 7, 169-177.

Barnes-Holmes D, Barnes-Holmes Y, Smeets P, Cullinan V, & Leader G (2004). Relational Frame Theory and stimulus equivalence: Conceptual and procedural issues. *International Journal of Psychology and Psychological Therapy, 4,* 181-214.

Barnes-Holmes D, Hayden E, Barnes-Holmes Y, & Stewart I (in press). The Implicit Relational Assessment Procedure (IRAP) as a response-time and event-related potentials methodology for testing natural verbal relations: A preliminary study. *The Psychological Record.*

Barnes-Holmes D, Hayes SC, Dymond S, & O'Hora D (2001). Multiple stimulus relations and the transformation of stimulus functions. In SC Hayes, D Barnes-Holmes, & B Roche (Eds.), *Relational Frame Theory: A post-Skinnerian account of human language and cognition* (pp. 51-71). New York: Plenum.

Barnes-Holmes Y, Barnes-Holmes D, Roche B, & Smeets PM (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 PM (2001b). Exemplar training and a derived transformation of functions in accordance with symmetry: II. *The Psychological Record*, *51*, 589-604.

Cattel RB (1971). *Abilities: Their structure, growth and action*. Boston: Houghton Mifflin.

Chomsky N (1959). Review of Skinner's Verbal Behavior. *Language, 35*, 26-58.

Devany JM, Hayes SC, & Nelson RO (1986). Equivalence class formation in language-able and language-disabled children. *Journal of the Experimental Analysis of Behavior, 46*, 243-257.

Dixon MR, Small SL, & Rosales R (2007). Extended analysis of empirical citations with Skinner's Verbal Behavior: 1984-2004. *The Behavior Analyst, 30*, 197-209.

DSM-IV-TR (2000). *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*. Washington DC: American Psychiatric Association

Dugdale N & Lowe CF (2000). Testing for symmetry in the conditional discriminations of language trained chimpanzees. *Journal of the Experimental Analysis of Behavior, 73*, 5-22.

Dymond S, & Barnes D (1994). A transfer of self-discrimination response functions through equivalence relations. *Journal of the Experimental Analysis of Behavior, 62*, 251-267.

Dymond S, O'Hora D, Whelan R, & O'Donovan A (2006). A citation analysis of Skinner's Verbal Behavior: 1984-2004. *The Behavior Analyst, 29*, 75-88.

Griffee K & Dougher MJ (2002). Contextual control over stimulus generalization and stimulus equivalence in hierarchical categorization. *Journal of the Experimental Analysis of Behavior, 78*, 433-447.

Hayes SC (1994). Relational Frame Theory: A functional approach to verbal events. In SC Hayes, LJ Hayes, M Sato, & K Ono (Eds.), *Behavior Analysis of Language and Cognition* (pp.9-30). Reno NV: Context Press.

Hayes SC, Barnes-Holmes D, & Roche B (2001). *Relational Frame Theory: A post Skinnerian account of human language and cognition*. New York: Plenum.

Healy O, Barnes-Holmes D, & Smeets PM (2000). Derived relational responding as generalized operant behavior. *Journal of the Experimental Analysis of Behavior, 74*, 207-227.

Kyllonen PC, Lohman DF, & Woltz DJ (1984). Componential modeling of alternative strategies for performing spatial tasks. *Journal of Educational Psychology, 76*, 1325-1345.

Lipkens R, Hayes SC, & Hayes LJ (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology, 56*, 201-239.

Lee R, McComas J, & Jawlor J (2002). The effect of differential and lag reinforcement schedules on varied verbal responding by individuals with autism. *Journal of Applied Behavior Analysis, 35*, 391-402.

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

Lovass OI, & Wright S (2006). "A reply to recent public critiques…" *Journal of Early and Intensive Behavioral Intervention, 3*, 234-236.

Lovecky DV (2004). *Different minds: Gifted children with AD/HD, Aspergers syndrome, and other learning deficits*. London: Jessica Kingsley Publishers.

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 the Experimental Analysis of Behavior, 87*, 349-365.

MacCorquodale K (1969). BF Skinner's Verbal Behavior: A retrospective appreciation. *Journal of the Experimental Analysis of Behavior, 12*, 831-841.

McEachin JJ, Smith T, & Lovass OI (1993). Long-term outcome for children with autism who received early intensive behavioral treatment. *American Journal on Mental Retardation, 4*, 359-372.

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.

McKenna I, Barnes-Holmes D, Barnes-Holmes Y, & Stewart I (2007). Testing the fake-ability of the Implicit Relational Assessment Procedure (IRAP): The first study. *International Journal of Psychology and Psychological Therapy, 7*, 253-268

Miller N & Neuringer A (2000). Reinforcing variability in adolescents with autism. *Journal of Applied Behavior Analysis, 33,* 151-165.

Murphy C, Barnes-Holmes D, & Barnes-Holmes Y (2005). Derived manding with seven children diagnosed with autism: Synthesizing Skinner's Verbal Behavior with Relational Frame Theory. *Journal of Applied Behavior Analysis, 38,* 445-462.

Murphy C, & Barnes-Holmes D (in press a). Derived more/less relational mands with four children diagnosed with autism: Synthesising Skinner's Verbal Behavior with Relational Frame Theory II. *Journal of Applied Behavior Analysis*.

Murphy C, & Barnes-Holmes D (in press b). Establishing derived manding for specific amounts with three children: An attempt at Synthesizing Skinner's Verbal Behavior with Relational Frame Theory. *The Psychological Record.*

Murphy C, & Barnes-Holmes D (in press c). Establishing five derived mands in three adolescent boys with a diagnosis of autism: Synthesising Skinner's Verbal Behavior with Relational Frame Theory III. *Journal of Applied Behavior Analysis*.

Murphy C, & Barnes-Holmes D. (under submission). Establishing complex derived manding with children with and without a diagnosis of autism: Synthesising Skinner's Verbal Behavior with Relational Frame Theory IV. *Journal of the Experimental Analysis of Behavior*.

O'Connor J (2004). *Designing procedures to establish repertoires of derived relational responding*. Unpublished doctoral thesis, National University of Ireland, Maynooth, Maynooth, Co. Kildare, Ireland.

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

O'Hora D, Peláez M, Barnes-Holmes D, Rae G, Robinson T, & Chaudhary T (in press). Temporal relations and intelligence: Correlating relational performance with performance on the WAIS-III. *The Psychological Record.*

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

O'Toole C & Barnes-Holmes D (in press) Three chronometric indices of relational responding: The importance of relational flexibility. *The Psychological Record.*

O'Toole C Murphy C, Barnes-Holmes D, & O'Connor J (in press). Teaching flexible, intelligent and creative behavior. In RA Rehfeldt, & Y Barnes-Holmes, (Eds.), *Derived Relational Responding: Applications for Learners with Autism and other Developmental Disabilities*. New Harbinger.

Palmer DC (2006). On Chomsky's Appraisal of Skinner's Verbal Behavior: A half a century of misunderstanding. *The Behavior Analyst, 29*, 253-267.

Piskin V, & Williams WV (1977). Cognitive rigidity in information processing of chronic undifferentiated schizophrenics. *Journal of Clinical Psychology, 33*, 625-630.

Reese HW (1968). *The perception of Stimulus Relations: Discrimination Learning and Transposition*. San Diego CA: Academic Press.

Rehfeldt RA, & Chambers M, (2003). Functional analysis and treatment of verbal perseverations displayed by an adult with autism. *Journal of Applied Behavior Analysis, 36*, 259-261.

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

Roche B, Barnes-Holmes D, Smeets PM, Barnes-Holmes Y, & McGeady S (2000). Contextual control over the derived transformation of discriminative and sexual arousal functions. *The Psychological Record, 50*, 267-291.

Rehfeldt RA & Root SL (2005). Establishing derived requesting skills in adults with severe developmental disabilities. *Journal of Applied Behavior Analysis, 38*, 101-105.

Scanlon G (2007). *The utility of the Implicit Relational Assessment Procedure (IRAP): Measuring self-esteem profiles of children with special educational needs and assessing the attitudes of teachers to children with emotional behavioral difficulties in mainstream education*. Unpublished doctoral thesis, National University of Ireland, Maynooth, Maynooth, Co. Kildare, Ireland.

Sidman M (1994). *Stimulus equivalence: A research story.* Boston: Authors Cooperative.

Sidman M & Tailby W (1982). Conditional discrimination versus matching-to-sample: An expansion of the testing paradigm. *Journal of the Experimental Analysis of Behavior, 37*, 5-22.

Skinner BF (1957). *Verbal Behavior*. New York: Appleton-Century-Crofts.

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

Sundberg ML, & Michael J (2001). The benefits of Skinner's analysis of verbal behavior for children with autism. *Behavior Modification, 5*, 698-724.

Sundberg ML, & Partington JW (1998). *The Assessment of Basic Language and Learning Skills (The ABLLS): An assessment, curriculum guide, and skills tracking system for children with autism or other developmental disabilities*. Pleasant Hill, CA: Behavioral Analysts, Inc.

Turner MA (1999). Generating novel ideas: Fluency performance in high-functioning and learning-disabled individuals with autism. *The Journal of Child Psychology and Psychiatry and Allied Disciplines, 40*, 189-201.

Wilson KG & Hayes SC (1996). Resurgence of derived stimulus relations. *Journal of the Experimental Analysis of Behavior, 66*, 267-281.

Wulfert E, Greenway DE, Farkas P, Hayes SC, & Dougher MJ (1994). Correlation between self-reported rigidity and rule-governed insensitivity to operant contingencies. *Journal of Applied Behavior Analysis, 27*, 659-671.

Vogel R & Annau Z (1973). An operant discrimination task allowing variability of reinforced response patterning. *Journal of the Experimental Analysis of Behavior, 20*, 1-6.

Received, January 8, 2009
Final Acceptance, January 29, 2009